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TRANSACTIONS
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SECTION OF GEOLOGICAL SCIENCES

PLEISTOCENE CLIMATE *

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The explanation of the glacial-interglacial alternations of climate during the Pleistocene epoch seems to require a very different climatic regime in the Arctic region than exists currently. Although subzero temperatures prevail in this area at present, the only lands that can support permanent glaciers are those in proximity to open oceans that provide the moisture for the maintenance of such glaciers. The frigid northern margins of Canada and Eurasia are ice-free lands as a result of their scanty annual precipitation.

Based on the marine sedimentary evidence for an abrupt change in climate about 11,000 years ago, Ewing and Donn[1] postulated that the direct cause of Pleistocene climatic fluctuations was the alternation of the Arctic Ocean between an ice-free and an ice-covered state. The phenomena of phase change seemed to be the only one adequate to explain the abrupt 6° to 10° C. warming of the surface waters of the Atlantic Ocean and adjacent seas shown by changes in planktonic fauna. This abrupt effect has been described recently and documented more completely by Broecker *et al.*[2]

According to the theory of Ewing and Donn,[1] the ice-free stage of the Arctic Ocean could provide the necessary source for precipitation in those cold and relatively snowless lands peripheral to the present ice-covered Arctic Ocean. Changes in the atmospheric and oceanic circulation produced by the opening of the Arctic would result in a meteorologic structure that would further enhance the more direct effect of moisture provided by an ice-free northern ocean.

After a period of initial growth, the cooling effects of a growing ice cap would soon tap other sources of moisture.

With the freezing-over of the Arctic Ocean, a reversal of meteorologic conditions would terminate the growth of continental ice sheets in the Northern Hemisphere, followed by a period of glacial retreat. In all of this, climatic factors of secondary magnitude would produce minor glacial fluctuations that would be reflected in retreats and advances of the ice front.

Furthermore, according to Ewing and Donn, the termination of a glacial stage would be the direct result of the growth of the ice sheets, which

* Lamont Geological Observatory Contribution No. 410. This paper, illustrated with slides, was presented at a meeting of the Section of Geological Sciences on April 4, 1960.

thus act as a self-regulating factor. The lowering of sea level consequent upon the trapping of much moisture in continental ice would finally so decrease the interchange of water between the North Atlantic and Arctic oceans as to cause the Arctic surface to freeze over. Rather simple calculations based on observed heat transport indicate that at stages of high sea level an adequate heat transport into the Arctic basin occurs to maintain superfreezing conditions. At low stages of sea level, as glacial growth reaches a maximum, the severe restriction of flow in the strait between Iceland and Scandinavia would so decrease the heat transport into the Arctic that the latter would become ice-coverd.

The assumption of an open Arctic as a moisture fount provides a more rational explanation for observations of glaciation in northern Canada, the Canadian archipelago, and northern Siberia. It also provides a basis for explaining glacial-interglacial fluctuations by means of a purely terrestrial mechanism.

Pleistocene glaciation in the Southern Hemisphere, with the exception of that on Antarctica, has been described as a rather simple lowering of the snowline so that existing alpine or piedmont glaciers reached elevations lower than they do at present. Ewing and Donn explain this as a result of the global cooling from more widespread glaciation in the Northern Hemisphere. The increased albedo of the earth produced by greater reflection from ice and snow in glaciated areas and from clouds in the pluviated areas would decrease the terrestrial heat budget by several per cent. A further slight temperature reduction would occur at a given elevation from the lowering of the world-wide sea level.

It is now rather well documented that greatly increased pluviation occurred in the subtropical deserts of the world during stages that have been correlated with glacial ice sheet development. We have explained this effect as the result of a contraction in climatic zones and a southward deflection of northern mid-latitude storm belts. This meteorologic model would thus bring into juxtaposition polar and equatorial air masses, producing even greater precipitation in desert regions than occurs in temperate regions at present.

The initiation of Pleistocene glaciation has been postulated by Ewing and Donn as resulting from a displacement of the geographic poles from an open marine environment to their present thermally isolated positions. The effect of the location of the North Pole in the Arctic Ocean and the South Pole in Antarctica would cause the "trapping" of cold conditions in these regions and would set up the present strong climatic zonation, as opposed to the rather uniform climate that prevailed over the globe during most of geologic time. Once the North Pole became isolated in the Arctic Ocean, the sequence of glacial-interglacial events would develop, these oscillations being governed by the state of the surface of the Arctic Ocean and persisting for as long as this polar location continued.

Antarctica and Greenland, surrounded by open oceans, would be expected to maintain their ice sheets as at present, throughout glacial and interglacial stages, showing only relatively small fluctuations resulting from secondary climatic effects. Recent work by Zeller[3] indicates that Antarctica has had stable temperatures since at least the Third Glacial Stage.

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EXPERIMENTS ON PEKIN DUCKS TREATED WITH DNA FROM KHAKI CAMPBELL DUCKS*

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Before describing and discussing observations made on Pekin ducks following injections of DNA from Khaki Campbell ducks, it may be useful to make a few preliminary statements.

Our study, made in 1956, must be considered as a pilot study made by biologists anxious to know whether an investigator could hope to rediscover in vertebrates the results obtained in microorganisms by DNA action.

The Pekin ducklings used in our earlier experiment† were from the selected and carefully controlled Flamencourt breed (the most reliable available in France), but no strictly inbred strain was available. In spite of this disadvantage we thought it worthwhile to publish our findings. For one thing, the results were extremely unexpected; for another, we felt that other investigators might desire to reconstruct and verify these findings which, we felt, were of considerable importance.

Having now continued our studies for three years, during which we maintained the purity of the Pekin breed used in 1956, we are today able to give more extensive facts of value, although much work remains to be done before these findings can be considered definitely established. However, we are not so ingenuous, despite our own certainties, as to hope to convince many doubters. We here expose the morphological aspect of the birds treated and of their progeny.

Modifications

The principal object of this research has been to determine whether transformations induced by DNA in microorganisms can be obtained in vertebrates by injecting DNA from one breed to another breed of the same species.

To answer this question one of us (J.B.) turned to two breeds of domestic ducks, the characteristics of which are opposed to one another in a very precise manner. These opposing characteristics are cited in TABLE 1.

Contrary to our anticipations – we had expected modifications in the progeny of the treated ducks – these results appeared in the injected subjects themselves. Of the 12 Pekin ducklings injected at the age of

*This paper, illustrated with slides, was presented at a meeting of the Section on April 11, 1960.

†Thirty-six ducklings from the same lot were used: 12 treated and 24 controls.

TABLE 1

General characteristics	*White Pekin*	*Khaki Campbell*
Origin	Imported from China (?) Introduced in the United States 1873, in England 1874	Crossing between M. Rouen × F. Indian Runner (chocolate)
Body	Broad, of medium length	Deep, wide, and compact
Abdomen	Deep paunch carried just clear of the ground	Well-developed, at rear of legs, not sagging
Carriage	Almost upright, sloping downward to the rear	Slightly upright and symmetrical
Head	Large, broad, high skull, heavy cheeks	Refined in jaw and skull
Bill	Short, broad, thick, bright orange	Medium in length, well set in a straight line with top of skull, greenish to black
Legs	Strong and stout, set well back	Medium in length, not too far back
Plumage	Very abundant, buff to canary, sound and uniform or deep cream for M. and F.	M. Head, neck, stem, and wing-bar, bronze; rest of body of warm khaki F. Khaki all over, back and wings laced with lighter shade of khaki
Weight	M. 9 lb. F. 8 lb.	M. and F. 4½ lb.

7 days with DNA extracted from the genital cells and erythrocytes of male Khaki Campbell duck, one male of three, after receiving 5 mg. of DNA in 5 intraperitoneal injections and 8 females of 9 treated with 61 mg. of DNA showed modifications as follows.

Head and body. As distinguished from the Pekin duck, which has thick cheeks and a domed skull, the treated ducks develop a refined head with a flattened skull, not as globular as that of the Pekin. The body is curiously reduced, less upright, and more slender; the abdomen does not sag. The weight varies between 4 to 5 lb., whereas that of the Pekin is between 8 to 9 lb. (FIGURES 1*a* and *b*).

Because of its completely discolored tint and its external appearance, the plumage of the treated duck no longer has the characteristics of the Pekin.

Bill. Two modifications appeared. First, four of the nine females treated lost the orange-yellow color so characteristic of the bill of a Pekin. If sometimes the tint of the bill was more or less pale in the female Pekin because of a vitamin deficiency or at the end of the laying

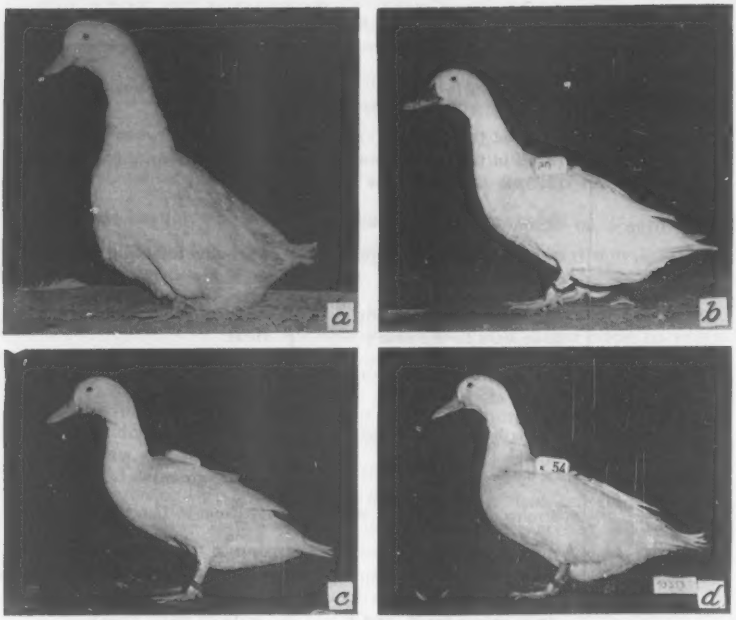

FIGURE 1. Four Pekin female ducks. *(a)* Control. *(b)* Experimental duck injected with DNA of Khaki. *(c)* First generation from injected modified ducks. *(d)* Duck of second generation from injected modified ducks.

season, it remained nevertheless constantly yellowish. On the contrary, in the four treated females the carotenoids of the bill completely disappeared, and the bill took on a pinkish tint similar to that found in certain common breeds, for example, the Aylesbury or the Merchtem.* Five other females kept the yellowish background of the bill of the Pekin.

A second modification is also concerned with the pigmentation of the bill. In five females (whether the bill was pink or yellow) a dark pigmentation spread over a great part of the bill (FIGURE 2*b*) different by its spacing and intensity from that on the bill of normal Pekin females (FIGURE 2*a*). This intense pigmentation thus far found only on the females treated with the Khaki DNA has developed and is actually very pronounced on all of them.

Web. We also noticed in 1959 that the web of our modified females became covered with minute pigmented spots of a particular pattern quite different from the more homogeneous stains found on some controls stains found on some controls (FIGURE 3*b*).

*R. Pero has analyzed Pekin and Khaki ducks on a genetic basis and found that Khaki Campbell have a pink gene for the bill: this could be of importance in understanding why, after Khaki DNA injections, the bills of treated Pekins were discolored.

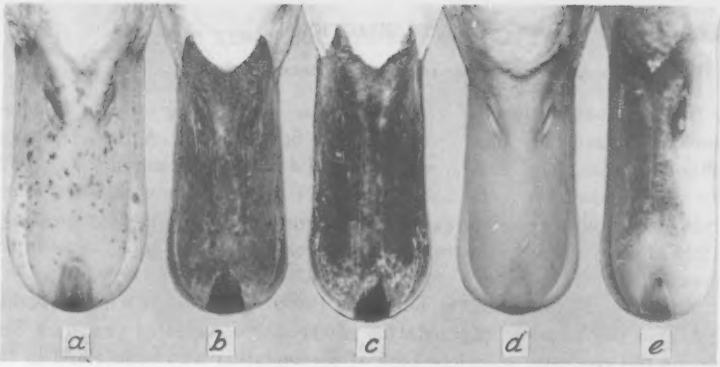

FIGURE 2. Pekin duck bills. *(a)* Female (mean type of 17 female controls), May 1959. *(b)* Female injected with DNA, modified (mean type of the 9 injected), May 1959. *(c)* Female of first generation from 2 injected modified Pekins. *(d)* Normal Pekin drake. *(e)* Male of first generation from 2 injected modified Pekins.

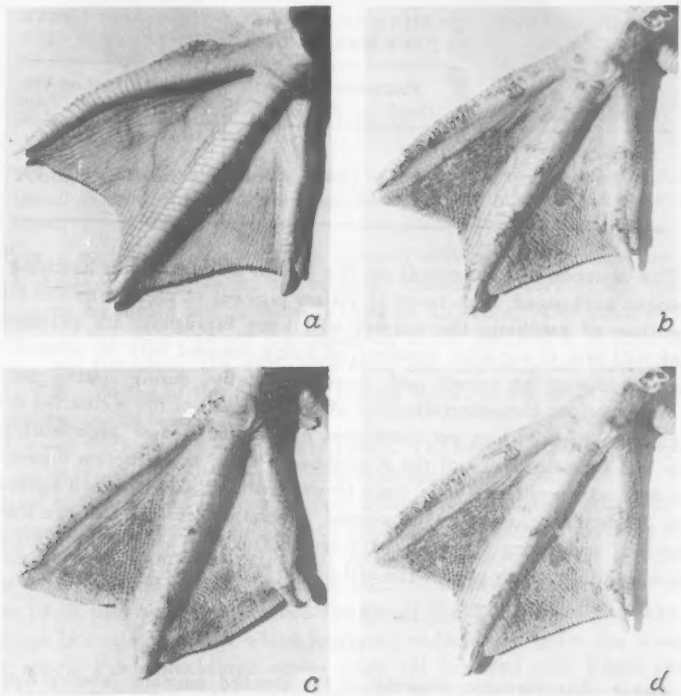

FIGURE 3. Webs of females. *(a)* Normal Pekin. *(b)* Injected modified Pekin. *(c)* Duck of first generation of injected modified ducks. *(d)* Duck of second generation of injected modified ducks.

Transmission to Descendants

Do the modifications of each particular type belong only to injected animals or are they also found in their descendants? A first positive, although incomplete, answer was provided during the month of July, 1957. We then lacked adequate installations for pedigreed reproduction. Since then we have seen the same characteristics in pedigreed ducklings hatched from the eggs of treated ducks, or from first descendants intercrossed with them, or with normal Pekins.

Not only the shape of the body and the plumage (FIGURES 1c and *d*) but also the acquired pigmentation of the bill reappeared (FIGURE 2c); or, on the contrary, complete lack of pigmentation was maintained in the descendants of the first, second, and third generations (TABLE 2). Moreover, the peculiar pigmentation reappeared on the webs of some females of the first and second generations (FIGURES 3c and *d*).

TABLE 2

RATIO OF PIGMENTED BILLS OF NORMAL AND MODIFIED DUCKS AT FOUR MONTHS OF AGE

No	*Pigmented*		*No spot on bill*	
	(No.)	*(%)*	*(No.)*	*(%)*
Normal	6	1	336	75
F1	37	52	33	85
F2	7	50	7	50

The absence of carotenoids on the bill is manifest after hatching and remains unchanged; if no trace of yellow pigment is present on the bill at the time of hatching, the subject will keep throughout its existence a pink bill that is capable, however, of being covered with an intense dark pigment during its growth and, more especially, during mating periods.

An important characteristic also affects the bill of the males. No investigator or breeder has yet mentioned having found dark pigmentation on the bill of male ducks of the Aylesbury, Pekin, or Merchtem breeds. As for the only modified Pekin male treated with Khaki DNA and several of his descendants, even in the second generation we found at the base of the bill and along its main axis unquestionably black-bluish pigment, recalling that which covers the bill of the Khaki duck (FIGURE 2e).

Hybrids

Other characteristic aspects of the treated animals involve hybrids. When a Pekin male is crossed with a Khaki female the result in the first generation is a Rouen or Mallard type (FIGURES 4*a* and *b*). This is a well known fact and one frequently used in breeding.

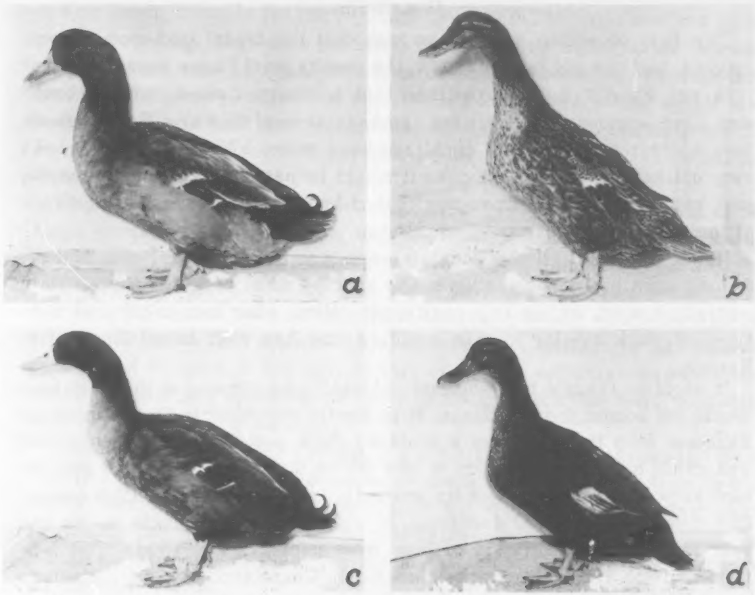

FIGURE 4. Hybrids. *(a* and *b)* Drake and duck from the crossing of Pekin and Khaki. *(c* and *d)* Drake and duck from the crossing of injected modified Pekin and Khaki.

When a modified Pekin drake is crossed with a Khaki female the results obtained are different. We obtained chestnut-colored types, rather dark, both for males and females (FIGURES 4c and *d*). The color of the plumage of the male has not the brilliancy of the mallard; it is generally brown, and the head, the neck, the rear, and the wing are particularly dark. The coloring of the female is almost black. In the male the bill is slate-grey, in the female it is black.

The web for both sexes is darkly tinted. The legs and fingers are yellow, as in the Pekin, but covered with dark spots.

Some of these hybrids have clearer coloration recalling, especially in the female, the pattern of feathers of the Rouen but without the wing bar.

The reverse interbreeding, Khaki male with Pekin female, or Khaki male with modified female, produces birds of identical appearance. The male is of the mallard type; the female of the Khaki type but with a plumage intermingled with white feathers, particularly under the wings.

In short, Pekin ducklings seven days old injected with Khaki DNA produce phenotypical characteristics that no longer resemble those of their original breed, those of other known breeds of *Anas platyrhyncha*, or of known hybrids between breeds. These modified birds transmit their new characteristics to their progeny as far as the third generation.

Discussion

The first objection made to us was that the birds used were natural hybrids: had one not injected DNA, the results would have been the same!

In any case it must be realized that a foreign male of another breed may have accidentally fertilized (perhaps several times) a Pekin female from which the "modified" ducklings have come. This hypothesis seems very unlikely, since in that case it would be necessary to admit that the pink coloration of the bill so manifest at hatching had escaped the notice of the breeder and the experimentalists.

If, as it seems, all the possible crossings between the Pekin and all the different breeds belonging to the species *Anas platyrhyncha* are only partially known, we are in a position to affirm, after long inquiry, that no type of duck similar to this modified one has ever been observed in France.

It might be thought that aberrant subjects were present at the duck farm where we bought the ducklings. It is hardly conceivable that animals as different from the Pekin as a modified duck could have gone unnoticed and could have reproduced on a farm where ducks kept were few and the farm known for the quality of its products. In fact, during the 1956 season this farm produced 600 ducklings of which 132 were bought by us and kept in our yard. Thirty-six of them were used: 12 as experimental subjects for DNA and 24 as their controls. Characteristics different from those of the Pekin were observed only among the ducks injected with DNA.

Moreover, the interbreeding of subjects from generators of different breeds will enable us to rediscover their characteristics in the descendants as long as the number is significant enough according to the usual Mendelian proportions. After three successive reproduction seasons, the meticulous examination of phenotypic characteristics of 2099 subjects (4 months old, hatched from our modified ducks interbred with one another or with Pekin and verified by inbreeding) has not yet revealed any other kind of duck but the Pekin, the modified and the hybrid Pekin X modified, and the modified of a special type not yet described.

We have remarked upon the absence of carotenoids or the bill of the four injected females. Instead of being yellow, the bill is pink. If this particular characteristic were not the result of treatment it might be supposed, first, that the bill of at least one of the parents of these four females was pink. Pero, following Rendel, has not been able to establish the fact that the pink characteristic dominates the yellow. We know that pink-billed ducklings always come from one or two progenitors having a pink bill. It seems hardly likely that the breeder to whom we turned would have maintained as reproducers such singularly "nonconformist" ducks.

It must also be supposed, as demonstrated by our studies on progeny, that the beaks of these four females were pink at birth and, therefore, that neither the breeder nor the experimentalists would have recognized during their extensive experimentation the presence of such an unusual phenomenon in the Pekin.

The Pekin controls for the injected animals (1799 birds verified by us on our breeding farm) were produced by inbreeding during three seasons and were all true to type. In cases of strict inbreeding, experimental nutrition deficiency, or lack of care, we obtained birds whose weight was reduced by one half but nevertheless retained characteristics of the Pekin type. We did not find any abnormality comparable to the modified type.

One previously mentioned fact must be emphasized here. In 132 ducklings purchased in 1956 from the previously mentioned farm, injected animals alone were modified in a ratio of 9 to 12. To explain these results through spontaneous mutation that would have affected 9 subjects in 132 hatched during the same season from the same strain would be without legitimate basis. The appearance of spontaneous mutants of an unknown type is not frequent in biology. In this case it is not only one new characteristic that has appeared but many characteristics that have considerably modified the original type.

Certain scientists have thought it possible to explain our results by a simple hypothesis: that a "wandering" gene in heterozygous state in our ducks would have become homozygous by a quirk of inbreeding, thus producing the modified type. According to these investigators nothing should be attributed to DNA; the simple play of gene adjustment accounts for the phenomenon.

This hypothesis is not acceptable to us because (1) too many other characteristics have been modified simultaneously in our subjects, and (2) homozygosis would not have occurred at the breeder's nor at our farm except in the case of the number of injected subjects. As a matter of fact, no one engaged in breeding whom we consulted was able to name our modified ducks.

If the pink character is dominant, as we have shown, its exteriorization cannot be explained by the crossing of normal Pekins.

In all diagnoses, from the first, presented in 1874 by G. P. Anthony in the *Poultry World* up to the latest, published in 1959, no allusion to such a modification can be found. Therefore, we can legitimately conclude that the Pekin breed has retained the same characteristics since it has been known. Perhaps modifying elements could have hindered the manifestation of a pink bill even if the gene were present, but how strange it would be to think that inbreeding would have suppressed not only the inhibiting action of such modifiers but would also have modified the shape of the body, the weight, and other characteristics in such an exceptional way.

These considerations render highly improbable the fact that genetic contamination has affected our material.

If, on the other hand, DNA is responsible for the changes described, how has it accomplished them? We cannot affirm that DNA alone provoked the observed modifications. It may in fact be believed that impurities of a protein or possibly polysaccharidic elements linked with physiological

factors or with factors of environment (physical and chemical), may have considerably modified the presumed action of DNA or, perhaps, the organism's receptivity. In so far as DNA is concerned, the separation of the nucleic acid from the nucleoproteinic complex was made in such a way that the biochemists found in the product a DNA of satisfying chemical purity (pigmented 8.05 to 8.48 per cent; nonpigmented 1.62 to 1.69 per cent).

These data do not indicate that we understand the modifying mechanism of DNA. Even the work of many investigators on the transformation of bacteria and on the relationship between the action of a microbial DNA and the normal mechanism of genetics actually cannot give us the long-awaited answer to this problem, which cannot be considered in terms of a single cell but must regard the organism as a whole made up of many disparate elements subordinated and coordinated toward a definitive end, namely "organic unity."

If, therefore, DNA exercises an influence in the modifications in question, we shall not imagine these to be results of an aggregate of independent cellular changes but the result of the modifying integration of injected molecules spreading their effects throughout the organism in a coordinated and consistent manner.

One surprising fact that was entirely unexpected was that modifications important as changes in the shape of the body and of the head occurred during postnatal ontogenesis. This is astounding. However, is it actually certain that a living being is irrevocably determined at the time of conception? Is it not possible that an adequate agent introduced at the right time in an experimental way could give a new direction to the evolution of the whole organism?

Many influences such as temperature and various chemicals are known to have affected embryonic and even postembryonic development. Considering the many proofs of biological plasticity, it seems difficult to deny such a possibility, and it would be hazardous to reject it *a priori*.

However, another circumstance must be considered. In spite of our efforts to achieve the same results we obtained in the 1957 experiments on ducks of the same origin, we have met only with failure. We have not been able to observe, during the course of our last experiments, results comparable to those previously described. This is a fact; however, we do not know whether, still later, similar results, dark pigment on the bills or on the webs, for example, would not have appeared if we had had the opportunity of housing our animals for a longer period and the financial support necessary for feeding them.

Unforseeable elements have perhaps modified the physiological quality of newly extracted DNA or individual physiological conditions have prevented the repetition of the same effects. Let us not forget that bacteria treated with DNA do not individually answer equally (a ratio of 1 to 10^2 or 1 to 10^3 is affected by the treatment).

In conclusion we may say that, at least a problem has been defined, the importance of which is undeniable. The more biochemists deepen their knowledge of the structure and physiological qualities of nuclear acids, the more easily will biologists improve their experimentation in this connection.

A new group has begun to form around one of us (U.B.), made up of geneticist-statisticians and other biochemists, the latter studying the plasma and blood of our birds, the composition of hemoglobin and of the egg-albumin, and the phenomenon of immunity.

The problem, when attacked by these investigators, will be less arduous to solve, and perhaps we shall be able to find an approach to its solution.

Summary

A brief account of experiments performed on Pekin ducks injected with DNA from Khaki Campbell ducks has been given. Unexpected modifications were observed in 9 of 12 ducks treated with DNA, while 24 controls did not show any abnormality. The modified animals transmitted their new characteristics to their progeny as far as the third generation.

The reproduction of modified ducks interbred with one another or with inbred Pekin ducks has produced nearly 3000 subjects, 2099 of whom were meticulously examined at the age of 4 months. This examination has not revealed any kind of duck other than the Pekin, the modified, and the hybrid Pekin × the modified; 1799 subjects born from the inbred controls were all true-to-type. The idea of genetic contamination of the material used in this experiment is at least highly improbable. No explanation has been given of the mode of action of the injected DNA.

CELLULAR IDENTITIES IN THE PARS DISTALIS OF THE RAT PITUITARY*

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There is now considerable evidence from light and electron-microscope studies of the pituitary gland that the pars distalis contains at least two types of basophil (Halmi, 1950 and 1952; Purves and Griesback, 1951*a*, *b* and *c;* Farquhar and Rinehart, 1954*a* and *b;* Peterson, 1957). The first (FIGURE 4) is polygonal-shaped, with a large cell body centrally placed in the cell cords, having small contact with the sinusoids, and containing fine glycoprotein granules colored positively by the Gomori aldehyde fuchsin and the paS stains. These cells undergo marked degranulation and cytoplasmic vacuolation after thyroidectomy and are thought to be responsible for thyrotropin production (Purves and Griesback, 1951*b* and *c*). The other type basophil (FIGURE 3) is smaller and more rounded, and is situated close to the sinusoids. Its cytoplasm contains coarse paS-positive glycoprotein granules. Following gonadectomy, some degranulation and a gross cytoplasmic vacuolation indicate its gonadotropic role (Purves and Griesbach, 1951*a*). Hildebrand *et al.* (1957), on the basis of a red to purple variance in paS staining, and Farquhar and Rinehart (1954*a*), from experimental and fine structural evidence, have differentiated between FSH-producing and LH-producing gonadotropes. We are investigating the pars distalis of the rat pituitary by light and electron microscopy under normal and experimental conditions.

Direct Cellular Identification in Electron Micrographs

The same cell field can be visualized by both light and electron microscopy in adjacent thick and thin sections (FIGURES 1 and 3, 2 and 4). In our studies on male rats, we have observed only one form of gonadotropic basophil. These paS-stained cells, rounded and sited close to blood vessel walls, contain spherical membrane-bound secretory granules of uniform density, most of which range from 0.05 to 0.2 μ; but larger sizes up to 0.3 μ are found. The centrosome area, in which the smaller secretory granules are abundant, is often loosely circumscribed by membrane bundles comprising the lamellated Golgi component (FIGURE 7). The endoplasmic reticulum, although comparatively scant, is cisternal and freely intercommunicating while the mitochondria are pleomorphic but otherwise not remarkable. The angular, rather stellate, thyrotropic baso-

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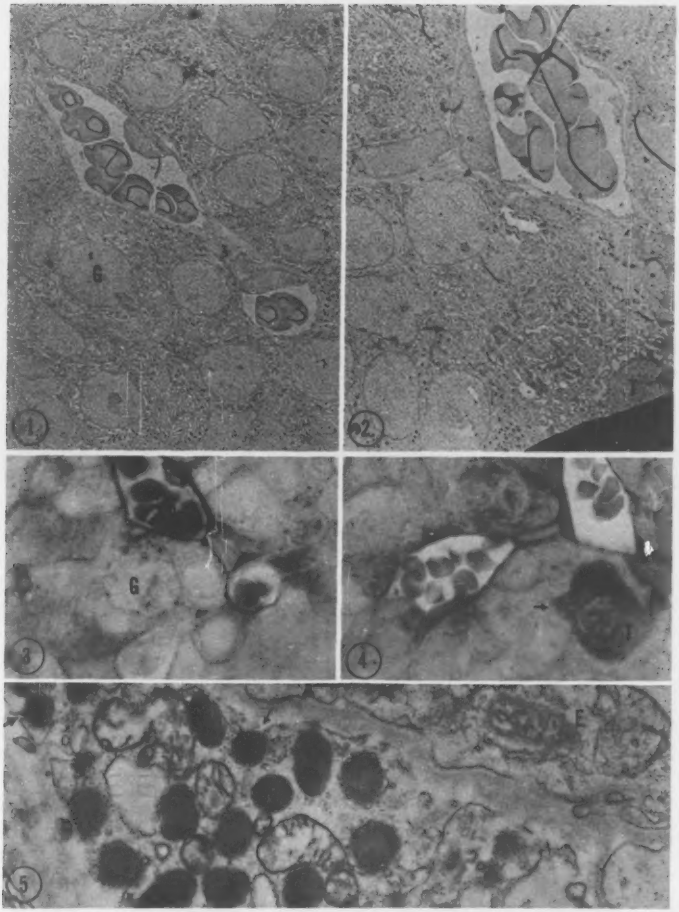

FIGURE 1. Low power electron micrograph of a gonadotropic basophil (G) adjacent to a sinusoid. Note the rounded shape, the small granules, and the dilatation of the endoplasmic reticulum. Compare with FIGURE 3. X2,500.

FIGURE 2. Low power electron micrograph of a thyrotropic basophil (T). Note the angular shape with a process extending to the left (*see arrows*, FIGURES 2 and 4) and small granules. Compare with FIGURE 4. X3,000.

FIGURE 3. The same field as shown in FIGURE 1 in the adjacent thick section stained with paS. Note the rounded shape and coarse paS-positive granules in the gonadotropic basophil (G). X1,400.

FIGURE 4. The same field as shown in FIGURE 2 in the adjacent thick section stained with paS. Note the irregular shape and over-all staining of the thyrotropic basophil (T). X1,400.

FIGURE 5. An acidophil process in a perivascular space. Note that some of the oval secretory granules (*arrow*) are in communication with the outer surfaces of the cell and thus the perivascular space. The endothelium of the sinusoid (E) is on the right. Female rat. X30,000.

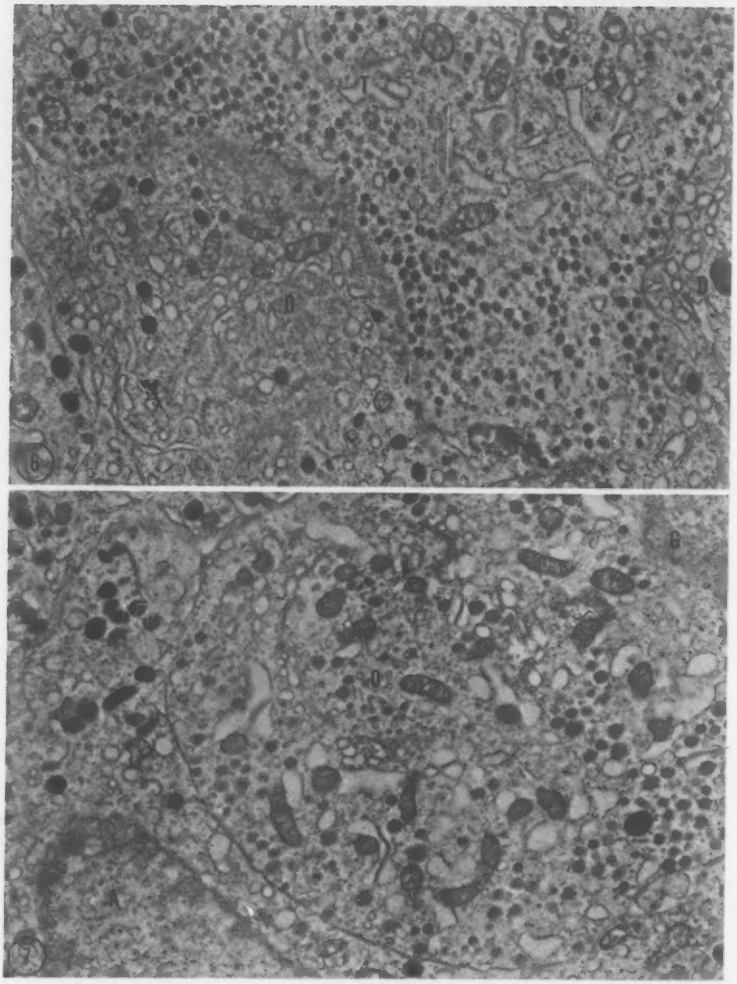

FIGURE 6. A process of a thyrotropic basophil (T) insinuated between two acidophils (D). Note that these basophil granules are almost uniform in size and each surrounded at a slight distance by a smooth membrane. The angular shape of this type of cell is suggested by its appearance. The adjacent acidophils (D) are only sparsely granulated. X15,000.

FIGURE 7. A gonadotropic basophil (G) of rounded shape and an acidophil (A). The gonadotrope granules are membrane-bound, uniform in density but variable in size, the smaller ones being common within Golgi sacs (0). X15,000.

phil has a background cytoplasm noticeably more electron-dense than that of the gonadotrope (FIGURE 6). The thyrotropic secretory granules in general do not fill completely the smooth sacs that contain them. They range in size from 0.05 to 0.13 μ and show wide variation in density, some of them being barely discernible as granules (FIGURE 6). The mitochondria and Golgi membranes are not remarkable, and the granular endoplasmic reticulum is saccular or cisternal in form.

There are also two varieties of acidophil in the pars distalis of the rat. The first is more numerous and conspicuous, and it contains uniformly dense granules, clearly membrane-bound and diverse in size (0.05 to 0.3 μ). In these acidophils (FIGURES 6 and 7), regarded by Farquhar and Rinehart (1954) as growth hormone-producing, the granular endoplasmic reticulum is arranged in long parallel sheets and frequently in *nebenkern* formations at the center of which a cluster of secretory granules may often be seen. The other and second type of acidophil is characterized by its content of lower density oval granules (FIGURE 5), some of which are as large as 0.4 μ. The granules are clearly bounded by smooth membranes, a feature particularly obvious in the Golgi region where these investments are probably acquired. The cytoplasm of this acidophil is deeply divided by long, irregular, and freely interconnecting sheets and cisternae of granular endoplasmic reticulum. Processes from these cells appear to extend into the perivascular spaces and are applied to the basement membrane on the outer aspect of the sinusoidal endothelium. In these processes (FIGURE 5), the membranes enclosing some of the oval secretory granules may be observed to be connected to the plasma membrane in such a way that the secretory material is in free communication with the perivascular space: indeed, granules have been observed lying freely in this space. This second type of acidophil may be identical with that to which Hedinger and Farquhar (1957) ascribe the production of lactogenic hormone.

Cytological Changes after Gonadectomy and Thyroidectomy

Our experimental observations to date largely repeat those of earlier workers. Thyroid removal is followed by a rapid degranulation of the first type of acidophils and an increased number of thyrotropic basophils. Furthermore, after thyroidectomy, these basophils, in time, become progressively degranulated and their cytoplasm disorganized by great saccular dilatations. This is the so-called "thyroidectomy" cell. We find that both acidophil and basophil secretory granules can be restored by thyroxine administration.

Gonadectomy is followed by an increased number of basophils of the gonadotropic type, but although some granulation of these cells follows orchidectomy, the typical castration cell, unlike the agranular "thyroidectomy" cell, continues to contain some secretory granules. The castra-

tion cell ultimately becomes swollen because of saccular cytoplasmic dilatation.

Space does not permit further exposition of our experimental results, which will be presented fully elsewhere.

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DIVISION OF PSYCHOLOGY

PUPILLARY REACTIVITY AS A MEASURE OF AUTONOMIC BALANCE IN THE STUDY OF PSYCHOTIC BEHAVIOR: A RATIONAL APPROACH TO CHEMOTHERAPY *

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Various measurements have been made of the response to stress employing the following variables that reflect autonomic activity: pulse rate, blood pressure, skin circulation, and response to adrenalin (Finkelman and Stephens, 1936; Pfister, 1938). The results of these studies indicate that chronic schizophrenics are less reactive than healthy people. When many series of measurements are made of basal metabolic rate, circulation rate, body temperature, excretion of 17-ketosteroids, thyroid activity, and water metabolism in schizophrenics and in healthy people, it is found that the variance of the measurements is significantly greater for the schizophrenics (Richter, 1957). These studies suggest that a concomitant of schizophrenia is some disorder of homeostasis: a disordered response to stress. Smythies (1958) recognizes that the onset of schizophrenia is commonly linked to some specific stress, "perhaps a battle stress, or emotional, interpersonal, or biological stress." At this point I introduce my theory by restating the above quotation. The onset of a functional psychosis may be commonly linked to a disordered response to stress; that is, a sudden emergency experienced as a threat to the physical or psychological well-being of the organism. Since Cannon's formulation of his Emergency Theory of Emotion, it has been generally accepted that when an organism is confronted with a sudden emergency the resulting massive autonomic response is functionally adaptive. Specifically, a massive and complete mobilization is achieved by the sympathetic division of the autonomic nervous system with the resultant secretion of great quantities of epinephrine and norepinephrine; or, as Grenell states in Fulton (1949), "The so-called 'fight, flight, or fright reaction' is a product of maximal generalized sympathetic activity." The role of the parasympathetic autonomic nervous system during the emergency reaction has been conspicuously neglected and relegated to the protection, conservation, and restoration of bodily resources. The hypothesis here offered is

* This paper, illustrated with slides, was presented at a meeting of the Division on April 18, 1960.

The second experiment described in this paper was repeated at Warren State Hospital, Warren, Pa., in the summer of 1959, on 60 chronic functional psychotics and 20 normal individuals. The results of the experiment confirmed the findings presented in this report.

that the requisite maximal generalized sympathetic activity ensuing the perception of threat is facilitated by a decrease in parasympathetic outflow in normal, healthy people. It is conjectured that, were parasympathetic outflow to increase or remain at the level of nonstressful states during the time the organism is mobilizing for an emergency, the net sympathetic response would be less than maximal. As a corollary, it is inferred that the disordered response to stress that characterizes the functional psychoses consists of significant departures from this characteristic interaction of the adrenergic and cholinergic components of the autonomic nervous system during stress.

It is further hypothesized that the disordered response to stress in the functional psychoses may involve either malfunction of the sympathetic (adrenergic) mechanism or the parasympathetic (cholinergic), or both, leading to significant departures from that reaction requisite for maximal mobilization of the organism. A hypothetical matrix of varieties of disordered responsiveness to stress has been constructed by reviewing the efficacy and mode of action of certain drugs already employed with varying success in the treatment and control of psychotic behavior. From the following evidence it has been deduced that disordered responsiveness to stress may be characterized by either an excessive or deficient adrenergic response mechanism.

Iproniazid (Marsilid) has been used extensively in the treatment of mental depression. *In vivo* studies with iproniazid on animals indicate that it can produce a relatively rapid and large (threefold) rise in brain serotonin (Zeller *et al.*, 1955). According to Truitt (1958), it is likely that iproniazid, through its inhibition of monoamine oxidase in the brain, potentiates the action therein of endogenous stimulant biogenic amines, epinephrine, serotonin and possibly, norepinephrine. The implication here is that some psychotics who are benefited by iproniazid may be defective in some brain catecholamines or in central adrenergic stimulation.

When one turns to the treatment or control of the schizophrenic reaction, it is found that reserpine and chlorpromazine have been extensively used. Brodie and his associates (1955) have shown that the excretion of 5-hydroxy-indoleacetic acid, a metabolite of serotonin, was markedly increased following the administration of reserpine. Furthermore, it was found (Pletscher *et al.*, 1956) that the administration of reserpine markedly decreased the serotonin levels in the brain. As reserpine depletes the store of biogenic catecholamines in the brain, it is possible that in those instances where reserpine therapy proves effective it may be due to the elimination of excessive concentrations of the biogenic amines in subcortical centers. The limited efficacy of reserpine therapy therefore suggests that some psychotics may be characterized by an excessive adrenergic activity in subcortical centers. This same conclusion is applicable also when chlorpromazine is con-

sidered for in addition to its peripheral antihistaminic and anticholinergic effects, this compound has been shown to have an adrenergic blocking action.

In summary, it is postulated that the disordered responsiveness to stress that characterizes some psychotics may be due either to a neurohumoral deficiency of some sympathomimetic amine or to some enzyme disorder such as monoamine oxidase overactivity in the adrenergic excitatory mechanism of the brain; or to a neurohumoral overabundance of some sympathomimetic amine or to some enzyme disorder such as monoamine oxidase underactivity in the adrenergic mechanism of the brain.

There are suggestions that the cholinergic component of generalized autonomic activity is also involved in the disordered responsiveness to stress that characterizes psychotic behavior. Forrer (1956) has recommended the use of large doses of tertiary atropine in the treatment of manic-depressives in the manic phase. As the pharmacological action of atropine is that of a cholinergic blocking agent, it may be inferred that excessive brain acetylcholine or deficient acetylcholinesterase characterizes some psychotics. Hoffer (1957) also has claimed that excessive parasympathetic activity, with concomitant increases in the concentration of acetylcholine, is an essential feature of the schizophrenic process.

Pfeiffer *et al.* (1957), on the other hand, have reported that some schizophrenics respond with a lucid interval to stimulation by cholinergic stimulants such as pilocarpine, arecoline, and 2-dimethylamine ethanol. The implication of this report is that some psychotics are characterized by defective cholinergic responsiveness. Recently, Rubin (1958*a*, 1958*b*) measured the rate of hydrolysis of acetylcholine chloride by erythrocyte cholinesterase and found that some psychotics may be deficient in cholinergic activity while others may be characterized by excessive cholinergic activity.

A hurried review of the evidence presented may at first seem replete with paradoxical facts and theories. Initially it appears that an effective chemotherapy for some psychotics should strive towards increasing central adrenergic activity. Then it seems that more effective drugs that decrease adrenergic activity should be developed. Additional conflict is raised by assertions of efficacy for cholinergic as well as anticholinergic drugs. These apparent contradictions may be resolved by viewing *the population of "functional psychotics" incapable of an organized normal response to stress as consisting of a specifiable number of discrete patterns of adrenergic-cholinergic levels of reactivity.* It is assumed that in the population of psychotics there may exist three levels of adrenergic activity including overreactivity and deficiency of sympathetic outflow, as previously described, in addition to a normal level from which directional deviations are measurable. The cholinergic

outflow may also be described as consisting of three levels of over-reactivity or deficiency of cholinergic levels as measured by reference to a level characteristic of the unstressed normal. The matrix of autonomic steady states derivable from such a paradigm is presented in FIGURE 1. In this figure *A* represents central adrenergic activity and *C*, central cholinergic activity. The levels of activity of each dimension are symbolized by +, 0, and –. The plus, or positive sign represents excessive activity; the zero, normal activity; and the minus, or negative sign, deficient activity. That level represented by Group V (*AoCo*), characterizes the level of adrenergic and cholinergic activity in the unstressed normal individual. The eight other combinations represent hypothetical adrenergic-cholinergic levels of humans under stress.

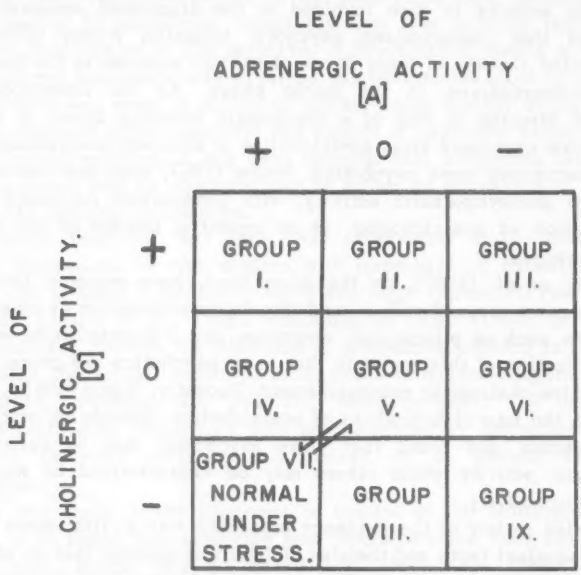

FIGURE 1. Hypothetical patterns of adrenergic-cholinergic interaction for normals and psychotics.

Previously the hypothesis had been developed that a normal response to stress consists of maximal generalized sympathetic activity that is attained when cholinergic stimulation is decreased (*C*–) while adrenergic stimulation continues to increase (*A*+) up to that maximal level that characterizes the individual. This characteristic adjustment is represented in FIGURE 1 as Group VII, and may be represented as *A*+*C*–. It is now further hypothesized, within the framework of the general theory, that the remaining seven interactions represent the discrete patterns that comprise the population of functional psychotics. To

recapitulate, the major hypotheses tested in the experiment were: (1) effective adjustments to emergency situations require maximal generalized sympathetic response; (2) to attain a maximal level of sympathetic activity, it is not only necessary that increased levels of adrenergic activity follow the emergency but that the level of cholinergic activity decrease; (3) the disordered responses to stress that characterize the functional psychoses represent significant departures from the adrenergic increase and cholinergic decrease that characterizes the effective, adjusting individual during stress; (4) the varieties of disordered response to stress represent discrete levels of activity of interacting, adrenergic, and cholinergic mechanisms, that is, the disorder may represent an impairment of function of either the adrenergic, or cholinergic mechanism or both.

In order to test the hypotheses of the theory, a physiological measure of adrenergic and cholinergic activity was employed. The miotic response of the pupil to light and the mydriasis resulting in the absence of light were employed to measure cholinergic and adrenergic mechanisms respectively. The cholinergic nature of the activity of the oculomotor nerve under the influence of light has been proved by the positive assay for acetylcholine in the anterior chamber of the eye (Engelhart, 1931) and the disappearance of the light reflex after the injection of cholinesterase (Mendel and Hawkins, 1943). Conversely, the anticholinesterases induce miosis. The work of Poos (1939), Hess and Koella (1950), and Hess *et al.* (1950) on isolated radial preparations of the iris demonstrated contraction in response to small concentrations of adrenalin and noradrenalin. Since these substances are responsible for neurohumoral transmission in sympathetically innervated structures, these investigators believe it is reasonable to assume that a dilator muscle exists that responds to sympathetic excitation. In addition, Frohlich and Loewi (1910) had shown that the mydriasis induced by adrenalin is intensified by cocaine.

Since pupillary constriction had been shown to be dependent upon the liberation of acetylcholine and dilatation dependent upon an adrenergic mediator, the present study employed measurements of rate of dilatation as representing the kinetics of a general adrenergic mechanism, and the rate of constriction as indicative of the kinetics of the cholinergic mechanism. To this end, measurements were made of the rate of dilatation of the pupil in darkness and the rate of constriction of the previously dark-adapted pupil in the presence of light on normal subjects and psychotics. Limitations of space do not permit an adequate description of the apparatus, method, or statistical treatment of the data and consequently, the reader is referred to still another source (Rubin, 1960) for details of the experiment.

To test the hypothesis that normals react to emergencies with an increased adrenergic response and a decreased cholinergic response,

measurements of dilatation and constriction were made before and after the right hand of the subject was immersed to above the wrist in a cold-water bath maintained at 5° C.

Pupillary Reactivity under Stress

A statistical analysis of the rate of pupillary dilatation for the normal subjects under the control and cold pressor conditions indicated that although there were significant differences between the slopes of individuals within groups, the difference between group slopes was not significant. Coupled with the finding of a significant difference between group means, it was concluded that the curves under the control and pressor condition were significantly different and parallel. The cold pressor test increased pupillary dilatation significantly. This finding was interpreted as supporting the hypothesis that under a condition of stress the normal reaction of the human is an increased adrenergic outflow as measured by the reactivity of the pupil.

Statistical analyses of the rate of pupillary constriction for the control and cold pressor condition indicated that there was no significant difference between individual slopes within groups nor between group slopes, but that the group means did differ significantly. As opposed to the relationship observed during dilatation, the level of constriction of the pupil under the condition of a cold pressor test is decreased. This finding supports the hypothesis that under a condition of stress the normal human response is a decrease in cholinergic outflow as measured by the reactivity of the pupil.

A second experiment was designed to test two additional hypotheses previously described: the disordered responses to stress that characterize functional psychoses represent significant departures from the adrenergic increase and cholinergic decrease that characterize the effective individual during stress, and the varieties of disordered response to stress represent discrete predictable patterns of interaction of the adrenergic-cholinergic mechanisms.

Pupillary Reactivity of Psychotic Patients

The data in the second experiment were obtained from 15 control subjects between the ages of 19 and 40, including 8 females and 7 males. Twenty-four patients, 13 white males and 11 white females between the ages of 15 and 42 and clinically diagnosed as functionally psychotic by the psychiatric staff were employed.

Dilatation. The extent of dilatation expressed as a ratio between the fifth and sixtieth seconds, independent of individual differences in the final level of dilatation attained, was employed to characterize every individual. Assuming that the sample of healthy subjects employed in

the experiment was a random sample from a population with a normal distribution for the obtained ratio, then the sample mean, as an unbiased estimate of the population mean, was employed to determine the likelihood of obtaining values for the ratio that deviated significantly in the direction of excessive or deficient dilatation. The results of the analysis indicated that the members of the patient group fell into one of three discrete groups with respect to extent of dilatation. One group showed the same extent of dilatation as the normal controls (11/24), another group showed excessive dilatation (5/24), and the third group demonstrated deficient dilatation (8/24). It is clear that three levels of dilatation appear to characterize the sample of patients employed in the experiment. The hypothesis that three distinct levels of adrenergic activity as measured by pupillary reactivity were extant was confirmed.

Constriction. To determine the extent of constriction of the pupil independent of individual differences in final level attainable, a ratio was employed to characterize each subject. To avoid negative values, the final level of constriction in millimeters was subtracted from the invariably greater initial level in millimeters and then divided by the final level. The confidence limits of the ratio obtained for the normal sample were employed to determine the significance of deviations of patient ratios. The results of the analysis indicated that one group of patients manifested a significantly greater degree of constriction than the normals and that another group showed a significantly smaller degree of constriction than did the normals. Three of 24 patients had defective constriction relative to the normals, 15/24 had a tendency toward excessive constriction, while 6/24 possessed values that fell within the normal range. With respect to constriction, 3 levels of constrictive tendency were found in the sample of patients employed in this study: approximately 25 per cent of the patients showed no impairment in constriction, 12.5 per cent manifested retardation in constriction, and 62.5 per cent were characterized by an excessive tendency towards constriction.

The interaction of dilatation and constriction. The results of the preceding sections confirmed initial hypotheses concerning the varieties of levels of adrenergic and cholinergic activity as measured by pupillary reactivity. An extension of the above hypotheses was concerned with the matrix of defective steady-states characteristic of the varieties of the so-called functional psychoses. Thus, in FIGURE 1 seven patterns of adrenergic-cholinergic interaction, each characteristic of a discrete disordered stress state, were described. The demonstration of these patterns of interaction is derivable from the following considerations.

Eleven of 24 psychotics showed no impairment in the extent of dilatation. However, all of the members in this group manifested aberrant constriction. Nine of the 11 manifested excessive constriction, while

2 were deficient. Conversely, 6 patients of the 24 who showed no impairment in constriction, all were aberrant in the extent of dilatation, 5 had less dilatory tendency, and 1 had more than the controls. In confirmation of the hypothesis, it may be stated that all 24 patients employed in the study showed a significant impairment in either the tendency to dilatation, to constriction, or both.

Discussion

Accepting a view held by many and supported by numerous research findings, namely, that the functional psychoses represent a disordered response to stress, a theoretical framework was developed that was tested in a preliminary manner in this report. The accepted role of the sympaticoadrenal system in response to emergency situations was extended to include the role of cholinergic mechanisms. The specific hypothesis was confirmed that the characteristic reaction of the autonomic nervous system to stress in normal individuals consisted of increased sympathetic (adrenergic) activity and decreased parasympathetic (cholinergic) activity, as measured by pupillary reactivity.

The finding that the cold pressor test increased pupillary dilatation significantly was interpreted as supporting the hypothesis that under a condition of stress the normal reaction of the human is an increased adrenergic outflow. That is, assuming that the responsiveness of the dilator pupillae is an increasing monotonic function of the amount of adrenergic mediator liberated at the effector site, then it may be concluded that under stress a greater quantity of the adrenergic mediator is liberated. The decrease in the level of constriction of the pupil under the cold pressor condition suggests a decreased cholinergic outflow in normal humans under stress if it is assumed that the degree of constriction of the sphincter pupillae is an increasing monotonic function of the amount of acetylcholine liberated at the effector sites.

The significance of these findings, however, is contingent upon two basic assumptions: that the cold pressor test is representative and equivalent to other forms of physiological or psychological stress, and that the adrenergic and cholinergic reactivity of the pupil is representative of adrenergic-cholinergic mechanisms of interaction in vital neural integrative centers such as the posterior and anterior regions of the hypothalamus, respectively. If these assumptions are accepted, then the following interpretation of the results of the experiment may be made with reasonable assurance. When the normal human organism is exposed to a stress-engendering situation, autonomic mechanisms respond with an increased sympathetic (adrenergic) outflow and a decrement in parasympathetic (cholinergic) outflow. This reciprocal balance between the components insures maximal mobilization of the resources of the organism required for "fight, flight, or fright."

In support of the hypothesis that the functional psychoses may be

characterized by disordered responses to stress that deviate significantly from the adrenergic increase and cholinergic decrease of the normal under stress, it was first shown that the psychotic sample manifested three distinct levels of dilatation and three significantly different levels of constriction. Again, if it is assumed that the magnitude of pupillary dilatation is proportional to the quantity of adrenergic mediator liberated, it may be concluded that some of the patients liberated a quantity that was characteristic of normals at rest, others liberated more of the adrenergic mediator or had some enzyme disorder such as monoamine oxidase underactivity, and some liberated too little of the adrenergic mediator or had some enzyme disorder such as overactivity of monoamine oxidase. Assuming that the tendency toward constriction of the sphincter pupillae is proportional to the quantity of acetylcholine liberated, the demonstration of three levels of constriction suggests that in more than one half of the patients either excessive quantities of acetylcholine were liberated or that there was deficient acetylcholinesterase activity. In some patients insufficient quantities of the neurohumor were liberated or else enzyme activity was excessive. The cholinergic activity of some patients was equivalent to the level of normal subjects.

The findings that those patients who showed no impairment in the extent of dilatation all demonstrated impairment in the rate of constriction and that some patients who showed normal constriction all manifested impairment in dilatation confirmed the hypothesis that the disordered responses to stress that characterize the functional psychoses represent significant departures from the adrenergic increase and cholinergic decrease that characterize the effective, adjusting individual during stress.

That the functionally psychotic may be classified into discrete categories of adrenergic-cholinergic levels of activity throws reasonable doubt upon the current quest for a single chemical panacea for the treatment of psychotics. Instead, the results of the study suggest that each pattern of adrenergic-cholinergic activity may require a specific combination of drugs that differentially effect the level of activity of either or both components of the autonomic nervous system, assuming of course that the underlying biochemical defect is, in fact, reversible. While adrenergic and adrenolytic drugs and cholinergic stimulants and cholinergic blocking agents have been employed in clinical chemotherapeutic trials with limited success, it should be noted that administration of these drugs is generally not selective. Usually a behavioral evaluation is made of a sample of patients presumed to be representative of a homogeneous population of psychotics before and after a specific drug is administered. The value of the present study is that it seems to provide a rationale for the selection of patients who require distinct chemotherapies as determined by the specific pattern of adrenergic-cholinergic imbalance.

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DIVISION OF MICROBIOLOGY

THE STRUCTURAL STABILITY OF TOBACCO MOSAIC VIRUS

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Introduction

In many respects, tobacco mosaic virus (TMV) is unique. It was the first virus discovered, the first to be purified, the first shown to be built up of regularly arranged subunits, and the first from which infectious ribonucleic acid (RNA) was isolated. However, many of its fundamental biological, chemical, and structural properties are not unique. Crick and Watson[1] have suggested that all small viruses consist essentially of an infectious nucleic-acid core wrapped in a protective coat made up of a large number of regularly arranged small protein molecules, which may all be identical. This hypothesis was based largely on results obtained with TMV, but more recent studies on a number of small viruses have tended to confirm the generality of this conclusion.

The stability of an intact virus particle is much greater than that of the sum of its parts. Infectious RNA isolated from TMV is very labile, and the isolated protein subunits are easily denatured. Intact TMV, however, remains native and infectious over a period of decades at room temperature. This great stability is obviously the result of the interactions between the parts in the native virus structure. TMV is as yet the only virus for which a model can be built that gives a reasonably realistic representation of its structure. This model is based largely on the X-ray diffraction studies of the late Rosalind Franklin.[2] This structural information, together with the results of biochemical and physicochemical studies, makes it possible to draw some reasonable conclusions regard- the nature of the interactions that hold the parts of the virus together.

Structure of TMV

The structure of TMV has recently been reviewed by Klug and Caspar,[3] who have shown that, by combining the results from X-ray diffraction and other physical and chemical studies, it is possible to characterize the structure of the virus by a small set of accurately determined numbers. In the 3000 Å-long virus particle there are 2130 protein subunits of 17,400 mol. wt. arranged in a flat helix of pitch 23 Å. The single RNA chain of 2.1×10^6 mol. wt. consists of 6390 nucleotides.

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One protein subunit is structurally and chemically indistinguishable from any other. Its over-all shape can be approximated by an ellipsoid of revolution with a major axis of 70 Å and a minor axis of 20 to 25 Å. This is only a crude approximation since there are significant notches and crevices in the molecule. In the virus the subunits are close packed in the helical array. There is a hole left down the axis of the helix of radius about 20 Å, and the maximum radius of the particle is about 90 Å.

The RNA chain is coiled in a compact way between turns of the protein helix of pitch 23 Å at a radius of 40 Å. There are 49 nucleotides in each turn of the helix, and they are about 5 Å apart along the chain. The phosphate-sugar backbone must be folded in such a way that sequential groups of three nucleotides are equivalently related to each protein subunit.

Chemical Reactivity of the Virus

The protein part of the virus is unusually inert, partly because of its primary structure[4] and partly because of its packing arrangement.[3] The resistance to attack by most enzymes is principally due to the buried location of most reactive groups in the virus helix. Carboxypeptidase can remove the C-terminal threonine that must be near the outside end of the subunit but, since a proline residue is third from the end of the chain, further action is blocked. The *N*-terminal end of the chain is acetylated and thus unreactive. The ϵ–amino group of one of the two lysine residues appears to be involved in a secondary linkage, and the other is masked in the native virus. The extreme masking of the single sulphydryl group has a structural basis. The cysteine residue is located in a crevice, which accounts for it being relatively unreactive, even in the dissociated protein; in the intact helix, however, it is halfway between the inner and outer surface and can thus react only with small molecules, such as iodine and methyl mercuric nitrate, which can fit through the spaces between subunits. It is unlikely that the sulphydryl group plays any part in determining the folding or packing of the protein since cucumber mosaic virus 4, which contains no cysteine, has a structure very similar to TMV.

The buried location of the RNA in the helix accounts for its resistance to attack by ribonuclease. Its thermal stability in the virus, as compared to the lability of isolated RNA, is presumably due to its regular interaction with the protein. Small molecules such as nitrous acid and formaldehyde can, however, diffuse in through the helix to react with the nucleotides.

Protein-Protein Interactions

Native protein, prepared from TMV, degraded by alkali or acetic acid, will reversibly polymerize to give viruslike rods. X-ray studies[3] have

shown that the protein can polymerize in the same helical structure it has in the native virus. However, under other conditions, a variant structure consisting of the subunits arranged in stacked discs can be obtained. The kinetics of the polymerization-depolymerization reaction as a function of temperature and *p*H indicates that hydrophobic bonds and hydrogen bonds play a significant role in holding the subunits together. These inter-subunit bonds help stabilize the protein against denaturation.

From the nature of the virus structure, it may be expected that denaturation of the virus should, in general, proceed by the stepwise removal of subunits from the end of the helix. A subunit can be more easily removed from the end than from the middle of the helix, since fewer bonds need to be broken, and a dissociated subunit is more susceptible to denaturation than one in the helix. These conclusions are borne out by the kinetic studies on TMV denaturation and electron-microscope studies of partially degraded virus.

RNA-protein Interaction

The structure of the RNA in the virus is determined by the packing of the protein subunits since the protein can still form the same helix without the RNA. The RNA does, however, contribute significantly to the stability of the structure. Repolymerized protein can be disaggregated under much milder conditions than either the native or reconstituted virus. The protein particles shorten on drying, whereas the length of the intact virus is constant.

Salt links presumably occur between the phosphate groups of RNA and basic groups of the protein. This cannot, however, be the only interaction. There is evidence[5] that the combination of TMV protein with its own RNA is more specific than with nonviral RNA or even that of distantly related strains. Since there are three nucleotides associated with each subunit and the subunits are all indistinguishable, such specificity would imply that there is some simple regularity in at least part of the nucleotide sequence. It appears, therefore, that the RNA may contain the information necessary for it to link up with its own protein as well as the "code" for the sequence of this protein.

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THE STRUCTURE OF SMALL "SPHERICAL" VIRUSES*

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Investigations of several small "spherical" viruses have shown them to be structurally similar. These viruses are composed of protein subunits that pack to form a framework enclosing the nucleic acid. This hypothesis was made by Crick and Watson[1a-b] when the information available to them on tobacco mosaic virus[2,3] revealed that it was composed of crystallographically identical protein units of about 17,000 mol. wt. In addition, it was known that both turnip yellow mosaic virus (TYM)[4,5a-b] and tomato bushy stunt (TBS)[6,7] crystallize into cubic lattices. Because of the way in which the particles pack to form the cubic lattice, they must possess at least the symmetry of the lattice. Hence the particles would consist of at least 12 or 24 identical units, depending on whether the symmetry was tetrahedral or octahedral. However, it is possible for the particle to have icosahedral symmetry, which is higher than that of the lattice. Such a particle would have 60 subunits, or a multiple thereof, with five-, three-, and twofold axes of rotation. The centers of the subunits would be on the surface of a sphere, it would appear polyhedral, and the neighbors of each subunit would be the same. Other arrangements of the subunits are possible but, if the lattice is cubic, it would be expected that the virus particles would have cubic point group symmetry.

Electromicroscope Studies

The structure of the small viruses can be investigated either by electron microscopy or by X-ray diffraction techniques. Several small viruses have been examined under the electron microscope using phosphotungstic acid as a negative stain. The particles are scarcely distorted, and sufficient contrast can be obtained to display some of the structural details of the virus. Studies on adenovirus, type 5,[8] show that the shape of the particle is icosahedral and that it has 252 subunits that are approximately spherical. The particle does not possess icosahedral (532) symmetry since the number of subunits is not a multiple of 60 and they do not have the same neighbors. There are three kinds of units that form the protein shell of this icosahedral virus: (1) 12 at the vertices of the icosahedron having 5 neighbors, (2) 4 on each of the 30 edges with 6 neighbors in different planes, and (3) the remaining 120 occupying the faces, each having 6 neighbors in the same plane. Another virus of about the same size, herpes,[8] is composed of ring-shaped subunits, but their configuration is not as clearly defined as that of the units of adenovirus.

*This paper, illustrated with slides, was presented at a meeting of the Division on April 22, 1960.

Subunits of TYM[3] and poliomyelitis are observed in the electron microscope when stained with phosphotungstic acid. The shape of TYM is that of a triacontahedron[9] with 32 subunits located at the vertices of the polyhedron. The subunits do not pack to give 532 symmetry and are of two kinds: 20 have 3 neighbors and the other 12 have 5 neighbors. It is noteworthy that the holes between the subunits are along the 60 edges of the polyhedron and possess icosahedral symmetry. Subunits are also observed on poliomyelitis.[10] Their arrangement is more difficult to ascertain, although they appear to be at the vertices of a pentagon. Current studies of southern bean mosaic virus (SBM)[11] indicate the presence of subunits, but the details of their configuration have as yet not been determined. However, they are hexagonal in one projection. This is clearly seen when a suspension of virus crystallizes after it is sprayed on a grid for microscopy. Three crystallographic planes with only two or three layers of particles have been observed.

X-Ray Diffraction Studies

X-ray diffraction studies have been made on three spherical viruses in addition to SBM.[12] In order to obtain good diffraction patterns two conditions must be fulfilled: (1) the particles must be identical or near identical, and (2) they must be well-ordered to give crystals of relatively high perfection. Crystals of SBM satisfy these conditions. FIGURE 1 shows a pattern of such a crystal taken with the X-ray beam approximately parallel to the *b* axis. Reflections are observed down to spacings of 2.5 Å, indicating a high degree of crystalline perfection comparable with patterns obtained from crystalline proteins of much lower molecular weight. The secondary sets of concentric circles are reflections from the (2*h k* 0) and the (*h h* 0) zones. From this pattern, from one with the X-ray beam parallel to the *a* axis, and from precession films, it is found that there are 4 particles in a unit cell of dimensions $a = 295$ Å, $b = 508$ Å, and $c = 474$ Å. Although the crystal class is orthorhombic, the particles are arrayed to give hexagonal packing.

The symmetry of the virus is revealed on precession films of four projections. The conspicuous features of all of these patterns are the regions of high intensity in directions other than those of the lattice symmetry axes. These streaks of high intensity correspond to the transform of the individual particles that possess a higher symmetry than the lattice in which they pack. In fact, the directions are those of the 532 axes of the cubic icosahedral point group. The particle is oriented in the cell with its three perpendicular twofold axes parallel to the *a*, *b*, and *c* axes of the orthorhombic lattice.

The fact that the patterns display icosahedral point group symmetry should be interpreted with caution. In the case of TYM, although the diffraction patterns show streaks of high intensity[5] corresponding to 532

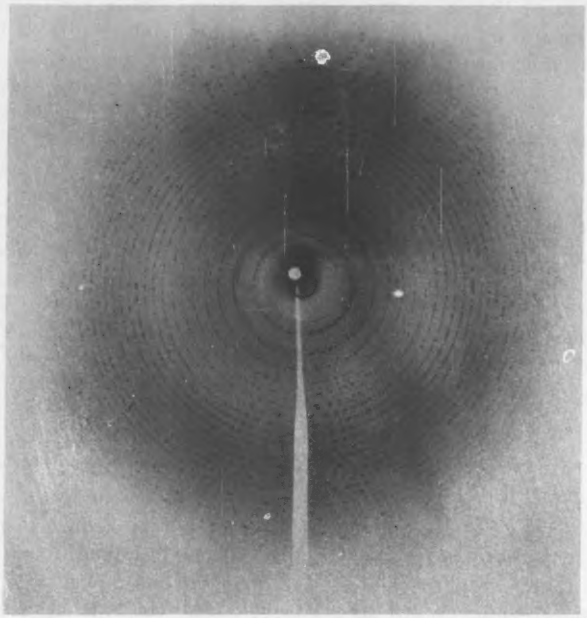

FIGURE 1. X-ray diffraction photograph ("still") of a crystal of southern bean mosaic virus taken with the X-ray beam approximately parallel to the *b* axis. Reflections appear down to spacings of 2.5 Å.

symmetry, the electron micrographs show only 32 subunits. Should the subunits of SBM form the protein framework of the virus with 532 symmetry, then there would be 60 identical or near identical units of 85,000 mol. wt. as calculated from the molecular weight of the virus of 6.63×10^6 and the 21 per cent nucleic acid.[13] These subunits may consist of more than one protein chain, and there is no requirement that all chains be alike. However, amino acid analyses[14] show that the protein chain has a minimum molecular weight of 27,000, suggesting that there may be three similar chains in each subunit.

The ribonucleic acid (RNA) is probably located within the protein shell since it is not degraded by ribonuclease under normal conditions. There are also further indications of this from preliminary experiments on the scattering of X rays at small angles from suspensions of the virus. The X-ray patterns from single crystals contain the information about RNA that cannot be interpreted at this stage of the investigation. However, because the particles are located at special positions in the unit cell and because of the lattice symmetry, the RNA can consist of 4 subunits if it is not a randomly oriented coil within the protein shell. The subunits are structurally alike but chemically dissimilar.

SBM differs from TBS,[7] TYM,[5] and poliomyelitis[15] in the general appearance of the X-ray diffraction patterns. The streaks of high intensity for the other viruses are narrow in the directions of the rotation axes of the 532-point group and are quite broad for SBM. This may be caused by the shape of the subunits or of the virus proper. The other difference is in the packing of the particles to form the lattice. TYM and TBS both crystallize in a body-centered cubic lattice and poliomyelitis in an orthorhombic cell that differs only very slightly from the body-centered cubic lattice. The shape may also affect the packing, so that the other viruses form a body-centered cubic lattice while SBM particles are arranged in hexagonal close packing.

Holes in the Protein Framework

That the virus may possess icosahedral point group symmetry does not give information about the shape of either the subunit or the particle itself. However, when the virus is purified in the presence of the plant sap, the protein shell has holes large enough to permit a ribonuclease molecule to enter it. Treatment with ribonuclease results in loss of infectivity (no local lesions appear on test plants) and an increase in absorption of ultraviolet at 260 mμ (FIGURE 2), showing a hyperchromic effect typical of degraded RNA.

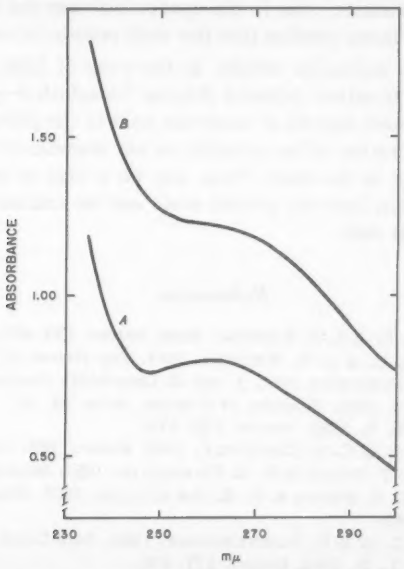

FIGURE 2. The ultraviolet absorption spectrum of southern bean mosaic virus; *A* the intact virus and *B* after treatment with ribonuclease.

The RNA of SBM virus can be degraded in this way only when the virus is isolated by ammonium sulfate precipitation. When the virus is purified by differential centrifugation ribonuclease does not hydrolyze the RNA and, consequently, the virus remains infective. Nor does the high concentration of ammonium sulfate change the protein shell of the virus since the preparation of virus isolated by differential centrifugation remains intact after several precipitations with ammonium sulfate. Hence it may be assumed that the active substance affecting the protein shell remains in the supernatant after ultracentrifugation, is of lower molecular weight than the virus, and is precipitated by one third saturated ammonium sulfate. Its absorption spectrum in the ultraviolet is that of a protein. Should this substance be an enzyme, it may be similar to the proteolytic enzymes found in most plants or it may be specific to the host plant. Further experiments with plant sap from infected and noninfected hosts are now in progress.

Conclusion

From electron microscopy and X-ray diffraction studies it would appear that the small viruses are composed of a protein framework that acts as a protective coat for the nucleic acid. Although their structures may differ in detail, several of them display icosahedral symmetry, if not in the packing of the subunits, then in the spaces between the units. It is quite clear from all of these studies that the viral protein is composed of units of relatively low molecular weight. In the case of SBM, its structure is such that the diffraction patterns display icosahedral point group symmetry, although there may be at least one hole in the protein shell. Apparently the configuration of the subunits is not disordered too greatly when holes are present in the shell. This may be a clue to the mechanism of the release of RNA from the protein shell and the initiation of vital replication in the host cell.

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DIVISION OF ANTHROPOLOGY

FRENCH GUIANA: MYTHS AND REALITIES *

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The only consistent verity about French Guiana is that every visitor who gets home writes about it. As one scientist remarked, "It must be infectious, something in the air! A bacillus with literary tendencies!"[1] I caught the disease even *before* going to French Guiana because I wanted to learn why it was so sparsely inhabited by contrast with neighboring Surinam and British Guiana.[2] Nevertheless, when I went to Guiana in 1957 and 1959, I found that most of my explanations were based on certain myths, while other myths proclaimed the contrary. Myths are essential; French Guiana relies upon them. Facts about the country do exist but are usually neglected; according to still another myth the facts are hard to obtain. When the French information officer in New York, N. Y. showed me her file on French Guiana, she apologized for its being so meager. "We have very few statistics from Cayenne," she explained, "because it is too hot to make statistics there."

The most familiar stereotype about French Guiana is what I shall call here the Devil's Island syndrome: the stock in trade of countless lurid books by escaped convicts and explorers. The titles of these publications convey the essence of the image: *Dry Guillotine, Fifteen Years Among the Living Dead, The Jungle and the Damned, Isle of the Doomed,* and *Hell on Earth.* These authors festoon French Guiana with murderers, rapists, and criminal lunatics from the sewers of Marseilles, the slums of Algeria, the dungeons of Indo-China, and quaint provincial villages where ordinarily mild-mannered citizens go berserk, poison their wives, dismember their mothers, garrote their publishers, or barbecue tax-collectors. In contrast are the unjustly accused, usually gallant foreign legionnaires or patriots framed for defending or destroying the Maginot Line. The prisoners are reputedly guarded by a crew of brutal and sadistic warders; when Emperor Louis Napoleon announced that convicts would be sent to French Guiana, it is said he was asked, "And who, Sire, will you find to guard them?" Replied the Emperor, "I will find worse than they."[3] Ancient and syphilitic prostitutes are sent out from France to live with warders and officials. The only other denizens of this mythical world are the Cayenne merchants who smuggle jewels and sell opium. They are served hand and foot by a few favored convicts who, no matter how grotesque their crimes, are faithful to their masters and wonderfully gentle with children.

* This paper, illustrated with slides, was presented at a meeting of the Division on April 25, 1960.

The other prisoners, chained with leg irons in the broiling tropical sun, work 15 hours a day felling giant trees with penknives or building a road to nowhere, the notorious Route de la Mort. The few survivors are thrown a crust of mouldy bread and locked in murky cells, where the stronger and more vicious pervert or murder the weaker. All are constantly racked by malaria, dysentery, yellow fever, leprosy, and gonorrhea; vampire bats suck their blood at night. To end these torments, prisoners commit suicide or attempt escapes, building with utmost patience small canoes out of coconut husks and match boxes. Most of them founder in the rivers and are set upon by piranha, small sharklike fish which reduce a man to a skeleton within minutes; or they wander for days in the tropical forest, dying of thirst, starvation, or cannibalism. Apparently only the literate survive to tell the tale.

The country is pictured in like manner. An equatorial sun beats down relentlessly on a parched plain that is, however, inundated for months at a time by torrential rains. The gloomy, impenetrable forest and fetid mangrove swamps are devoid of food, plant or animal. They contain only hoards of mosquitoes and sandflies, enormous ants and wasps, scorpions and snakes, chattering monkeys and screaming parrots, and bloodthirsty jaguars and hyenas. The sole products of the primitive Indians are poisoned arrows and poisonous cassava.

This mythology is just as widely accepted in France; the names of Cayenne and St. Laurent "still call to mind only the horrors of the convict prison."[4] Curiously enough, however, the penitentiary, founded in 1852, was originally meant to be the salvation of French Guiana. Slave emancipation in 1848 had deprived the colony of its labor supply; the convicts were to work for the planters and later to settle down as free peasants. "The penal establishment," wrote one scholar a century ago, "should bring a happy change to the sad state of this colony....Several new centers of European population have already been established, some even in the interior, which until now had been thought impossible on account of the insalubrity of the climate for white men."[5]

However, progress did not last long. Yellow fever and malaria soon decimated most of the settlements. Of 18,000 prisoners sent to Guiana, one half were dead at the end of the first 15 years.[6] Administrative expenses multiplied; for every hundred prisoners there were 25 or 30 guards, clerks, and other functionaries. The whole institution was riddled with graft. The cost of agricultural production by ex-convicts was three times the receipts. Public works begun by the prisoners were never used; like Penelope's weaving, roads and canals were built in order to be destroyed and rebuilt. Guianese planters, who had expected to get good labor cheap, had to pay the prison administration exorbitant sums for enfeebled malingerers. Fewer men than ever now migrated willingly to French Guiana; those who came sought gold, not agricultural work. Land under cultivation diminished by 80 per cent within a generation.[7]

To be sure, the Guianese themselves were not blameless. Less interested in long-term development than in immediate comfort, they used prison labor for personal services rather than for production. "Far from being considered a precious resource to be exploited as efficiently as possible, convict manpower ... was regarded as worthless and applied to the most absurd and useless tasks; a considerable proportion of the labor supply was long employed in carrying water and emptying tubs for the benefit of the Guianese."[8] The inhabitants of Cayenne grew so accustomed to having convicts fetch and carry for them that whenever anything was said in France about ending the penal system, they cabled a protest: they were "at a loss to know how the town can live if the convicts are taken away."[9]

Public opinion nevertheless forced France to discontinue sending criminals to Guiana in 1938. When repatriation began, after the war, there were 7500 on the prison roll. Only 2000 of these were real convicts and *relégués*, habitual petty offenders condemned to life exile in Guiana; 2300 were *libérés* who had served their sentences but preferred to remain; 3100 had escaped or died.[6] However, at no time did the prisoners comprise more than one fifth of the population of French Guiana; the remaining four fifths were ordinary folk, as law-abiding as most people anywhere. Even Devil's Island has been maligned. One of the three Iles du Salut, or "health," far from the main prison camp at St. Laurent, Devil's Island was in fact a relatively pleasant and breezy reserve for pampered political prisoners; their sole task was to gather coconuts for the camp kitchen. Plans are now afoot to make Devil's Island a tourist resort.

Seventy thousand men in all were transported to French Guiana, but almost none remain today. The last prisoners were returned to Europe and Asia in the early 1950s. With them went most of the *libérés*. Only 200 of the latter remain in French Guiana, less than 1 per cent of the total population of 29,000; these *vieux blancs*, for the most part frail and elderly Frenchmen, who do light work as artisans, gardeners, or minor civil servants, are generally harmless, alcoholic, and pathetic.

In the rest of the population are 1500 other Europeans: French officials and their families, a few score German and Swiss technicians, and a scattering of refugees from East Europe. Four-fifths of the population is Creole: in the local sense of the word not necessarily Guianese but Caribbean-born Negro or colored. The 23,000 Creoles include early immigrants from Martinique, descendants of British West Indians from Barbados and Dominica, and a large number of more recent arrivals from the island of St. Lucia known as *La Fidèle* because, although British-owned since 1815, it is still French in language and culture. However, at least 2000 St. Lucians in French Guiana are still British citizens and called "les Anglais." Several hundred Chinese monopolize the grocery trade; 250 Lebanese control the dry goods business; there are the Creolized offspring of indentured laborers brought from British India in the 1860s and

1870s, a few Brazilians, and 170 Javanese rice farmers who immigrated in 1955 from neighboring Surinam. All of these except the Javanese have readily assimilated and intermarried with the Creoles. Finally, there are the primitives: about 2000 Bush Negroes descended from slaves who escaped from Surinam plantations in the 18th century, and 1000 Amerindians of Carib, Arawak, and Tupi-Guarani stock.

The population as a whole is unevenly distributed: more than one half of the total lives in Cayenne and its immediate environs; 3000 are in St. Laurent on the western boundary; 8000 are scattered in small coastal villages lying chiefly between St. Laurent and Cayenne; only 3500 inhabit the interior, the 90 per cent of French Guiana comprised in the *arrondissement* of l'Inini.[10-11]

The country itself is totally unlike the noxious land of legend. Cayenne is not Paris, to be sure. Nevertheless, for a tropical town of 15,000 it is more respectable than one would guess from this 1938 description: "To see Cayenne is to see the depths of human degeneration. It is the sort of capital which should be expected in a colony which, after more than three hundred years as a French possession ... had only butterfly wings and stuffed monkeys to send to the Colonial Exposition."[9]

Two decades later we came to Cayenne after a sojourn in British Guiana and Surinam, each of which has 20 times the population and wealth of French Guiana; in Georgetown and Paramaribo one had become more or less used to fleabag beds, tasteless meals, dysentery, mud, dust, and sand flies. The contrast was startling. In Cayenne most of the streets are paved. There is an excellent hotel and three first-rate restaurants. The water supply is pure and copious. Electricity works almost all the time. If the architectural decor is somewhat dour and the public parks pathetic, the people seem cheerful and full of vitality. Public health in Cayenne is exemplary; malaria and yellow fever have been eliminated from the settled areas, and there are annual mosquito-eradication campaigns. The local Pasteur Institute wages an active battle against filaria and leprosy, and neither is now endemic. Nutrition is much more adequate than it used to be. Since 1946, births have annually exceeded deaths, and infant mortality has dropped from 146 to about 58 per 1000 births.[12] Babies seem ubiquitous.

Nature in French Guiana has also been slandered. Around Cayenne – as distinguished from other Guianese cities – granite hills break the monotony of flat swampland and afford spectacular views of city, coast, ocean, and forested interior. Cayenne has the only good beaches with sand and surf between the Amazon and the Orinoco. Near the coast the heat of the day is tempered by refreshing trade winds; the nights are cool and pleasant. It does rain a lot – 150 inches a year is the average at Cayenne – but seldom all day long. Instead, there are heavy spurts: 10 inches in two days at Cayenne, four inches in three hours at the airport, two thirds of one inch in 15 minutes at St. Laurent.[13] Between showers, the sun shines.

The climate is even more pleasant on the great rivers that are the only routes to the interior. By day the air is clear, the temperature never above 90° F., relative humidity in the seventies; at night blankets are a necessity, with the temperature at 65° or 70° F. One can suffer if one tries: an official of the *Sûreté nationale* wrote that on his canoe trip up the Maroni last year he was "exposed alternately to a broiling sun and to torrential rains. We were often forced to help our boatmen get through difficult passages; portages were long and often even dangerous; the whole trip slow and painful."[14] Such a man would go up the Hudson River from New York to Albany, N. Y. in January in a rowboat, and then complain of the cold and the contrary tide. Nothing could be more delightful than a properly provisioned and guided trip up the Maroni. Most of the dangerous plants and animals are imaginary. Except for birds, fauna of all kinds is scarce; starvation would be the chief risk in the tropical forest. Nevertheless, people continue to speak of the wild and dangerous interior. One explorer, on returning last year from southern British Guiana, remarked, "How people live there I don't know, but they are very brave."[15]

Brave they may be, but French Guiana's primitives are certainly not ferocious. The Bush Negroes are easy-going and hospitable, the Indian tribes with whom they share the interior are gentle and usually apathetic. Not even at the cowboy-and-Indian motion pictures in St. Laurent do they show much animation. Several dozen Roucouyenne Indians in red paint and bearing bows and arrows, with whom we attended a French version of Noah Beery in *The Bloody Tomahawk,* were mildly amused at the way Plains Indians scalped Yankee invaders.

One who assails old myths, however, is tempted to create new ones. Thus some depict French Guiana as being next door to Paradise. A leaflet persuades the prospective settler that "contrary to the widespread view, Guiana has a most endurable and even an often pleasant climate"; indeed, "the strength of the sun's rays is hardly greater than it is on the Riviera." Accounts of fabulous untapped riches dazzle the entrepreneur or investor. The tourist is enticed by descriptions of tropical verdure and beaches, tennis in the Place des Palmistes, and Cayennes colorful carnival and French cuisine.

The major components of what I shall call the Paradise syndrome are an El Dorado legend: the concept of French Guiana as a land of inexhaustible wealth; a Noble Savage legend exalting primitive virtues; and faith in *la mission civilisatrice,* the complete assimilation of Guianese Creoles as French citizens. To what extent are these legends and ideals true or attainable?

First, El Dorado: everyone has heard of the City of Gold with its gilded prince sought by Conquistadores in South America since the early 16th century. El Dorado was always just over the horizon; when explorers failed to find it in Colombia, Ecuador, and Peru, they moved it eastward into the jungle and eventually to Guiana, the last great *terra incognita* of

the continent. Long after Raleigh's final tragic expedition, mapmakers kept embellishing the empty Guiana interior with an immense inland sea surrounding a City of Gold. In the 19th century, Humboldt demonstrated that El Dorado was an optical illusion reflected from the flooded savannahs of the Rupununi River in British Guiana and the Rio Branco in Brazil.[16] However, the discovery of placer gold in rivers emerging from the Guiana Highlands revived visions of illimitable wealth; since the 1870s, tens of thousands have spent their lives hunting treasure there.

To French Guiana came fortune seekers from all over the world, their cupidity aroused by "true" stories such as George Michelle's "Riches Waiting for a Guy with Guts" *(Man to Man, the Stag Magazine,* February 1957); in a two-month trip the author claimed to have overcome the reluctance of the French "Governor-General," beat down murderous cannibal attacks led by a villain called Chief Poodle, and picked up 2 million dollars in diamonds (leaving quantities behind) in the "Riviere de la Mort," upstream from the village of "Malheur." This tale alone generated scores of requests for government permission, even assistance, in looking for diamonds. One young man arrived unannounced in Cayenne with his copy of *Man to Man* and demanded to be taken to the "Riviere de of Mort." The nonexistence of this river, the obviously Polynesian locale of Chief Poodle and his paraphernalia, and the entire absence, up to the present, of diamonds in French Guiana are facts that fail to dissuade confirmed treasure seekers.

A visit to the small placer gold mines scattered throughout the interior might make more of an impact. At these camps – aptly named Déchéance, Bas-Espoir, Patience, Perdu-Temps, Pas-Trop-Tôt, Maraudeur – a few score Creoles, mostly St. Lucian immigrants, laboriously sift river sand for gold dust, seldom earning more than enough for an occasional binge in St. Laurent or Cayenne. To be sure, gold is French Guiana's principal export. Mechanical dredging and exploitation of a newly discovered seam have increased official production figures since 1954 from 50 to 566 kg. a year: that is, to 18,000 bullion oz., or one fifteenth of 1 per cent of world output. Nonetheless, there is no geological prospect of an El Dorado, either in gold or in gems.

It is a different El Dorado that France envisages, less glittering but more possible. According to government brochures, French Guiana is full of unexploited natural resources: choice cabinet timbers, scarce pharmaceutical products, strategic minerals, and virgin soils. There is much truth in this. Rosewood has long been exported from Cayenne, and other potentially marketable forest species abound. Bauxite, which has transformed the economies of Surinam and British Guiana, also occurs in quantity in French Guiana; so do manganese and tantalite. The alluvial clay soils along the coast are no less fertile than those in the neighboring Guianas. A dozen impressive agencies have spent billions of francs mapping, prospecting, testing, and promoting: notably the Bureau Minier

Guyanais, l'Institut Francaise d'Amèrique Tropicale(L'IFAT), Société du Manganese de Guyane (SOMAG), Bureau Agricole et Forestier Guyanais (BAFOG), and Fonds d'Investissement pour les Départements d'Outre-Mer (FIDOM). For the manpower necessary to turn all this to account there is the Bureau pour l'Installation des Personnes Immigrées en Guyane (BIPIG).

Even were the labor supply adequate, all this work would need much time to come to fruition. Bauxite mining and forest exploitation both require transport facilities nonexistent in French Guiana. Over the past ten years, several new airstrips have helped join the scattered settlements of the interior, but outside the vicinity of Cayenne and St. Laurent the only road is the track, locally called Route Nationale Zero, that links the two towns. A narrow-gauge railroad connects the mining camp St. Elie with the Sinnamary River; the "train," an open truck, traverses the 20 miles in six hours and is derailed three or four dozen times each trip. In the interior the usual mode of transport is by canoe, but even the broadest rivers are unnavigable for larger craft owing to extensive sand and mud bars at their mouths and rapids 20 to 40 miles upstream. Cayenne's harbor is perpetually clogged with silt; steamers must anchor five miles from the city. Nevertheless, similar obstacles were overcome in order to mine manganese in sparsely inhabited Brazilian Guiana. Should French Guianese mineral wealth warrant it, equipment and financing necessary for exploitation would no doubt be forthcoming.

Any profits will be reduced, however, by the import costs of food for miners and lumbermen. Only 5000 acres are now cultivated at all, out of more than 600,000 deemed arable. However, prospects for large-scale development are poor. The deficiencies of tropical lateritic soils are well known; even in British Guiana, where one third of the agricultural labor force is unemployed or underemployed and land hunger is intense, no one seriously considers colonizing the hinterland. The soils of the Guiana interior are waterlogged or bone dry, predominantly acidic, and deficient in mineral and plant nutrients.[18]

What of the coastal zone, where the Dutch and British have for centuries grown sugar, coconuts, cacao, coffee, and rice on flood-fallowed soils of inexhaustible fertility? French Guiana has such soils. Nevertheless, the inhabited coastal strip west of Cayenne, where most efforts have been directed, is least promising; bedrock is close to the surface and sterile sand ridges alternate with acid swamps. Southeast of Cayenne a few plantations existed a century ago; here the fertile clay strip is broader and deeper and new deposits of Amazonian silt are extending the coastal plain seaward by as much as 100 yards a year.[19-20] However, to prepare such land for cultivation would require an expenditure of money and effort equivalent, perhaps, to draining and diking the Zuider Zee. Even in the epoch of slavery, the French never had manpower enough for this; they could hardly effect such a project today, certainly not with a small handful of independent, leisure-loving Guianese.

That brings me to the Noble Savage element of the Paradise syndrome. According to this Rousseauian counterpoise to Devil's Island, the aborigines of Guiana live simple, happy lives in a state of nature, unsullied by the corruptions of civilization; for other Guianese the good life involves selective emulation of the primitives in the context of French life and culture.

French sympathy for "les peaux rouges et les peaux noires"[21] is explicit in dozens of sensitive books about the Bush Negroes and the Amerindians. Admiration for their serene and leisurely way of life – the Indians are invariably pictured lying in hammocks – is often mingled with a romantic if erroneous view of them as the "last heirs of a civilization ... with the sunset glow of a noble past."[22] It is the firm policy, reinforced by direct prefectoral administration of the interior, to preserve Indian and Bush Negro ways of life and to protect them against outside contamination, whether from tourists, gold miners, or others. Indeed, the dismal squalor of coastal villages where Indians have been Creolized stands in woeful contrast to the neat and attractive settlements upriver, and is a striking apparent confirmation of the virtues of primitive simplicity and purity. However, this policy does tend to retard or discourage economic development in the interior.

A similar predicament inhibits productivity among the coastal Creoles. According to the mercantilist view that formerly prevailed in Paris, French Guiana existed primarily to benefit France. However, the Guianese stubbornly rejected their assigned role. "Their principal business," reported an English visitor to Cayenne in the 1750s, "is to find pleasures, and if they have any disquietude it is for the lack of them."[23] A generation later the energetic governor Malouet urged agricultural development of the lowlands; he was warned by Préfontaine, whose book *Maison Rustique* glorified the individualistic upland cultivation practiced in French Guiana, that the colonists would never give up their comfortable existence for hard and disagreeable labor in the lowland swamps. Governor Malouet noted that hunting, fishing, and local food crops gave the inhabitants of Cayenne "an abundance of the necessities of life"; after "a century of lethargy," they were understandably apathetic about exporting tropical produce to the mother country.[24]

To this day the Guianese way of life and attitude toward productive development remain substantially the same. "Too many Guianese," a French scholar concludes, "tend to live in a state of idle contentment, which is, I admit, most delightful under the skies of Cayenne."[25] The value of imports is eight times that of exports. Hunting is still the most popular occupation and the only steady source of meat; the peccary is said to be excellent, the scarlet flamingo less good. Cayenne's beef is flown in from Brazil in exchange for perfume and champagne. The local fish supply fell off drastically after 1953, when the fishermen, political prisoners from Vietnam, were repatriated: "Les Vietnamiens rentrait chez

eux, finie la pêche, dit-on de tous cotés."[26] (the Vietnamese returned to their homelands and there is no more fishing, it is said on all sides). Agriculture above the subsistence level is confined almost entirely to West Indian immigrants, as it was earlier to convicts and *libérés*. Of the 465 agricultural workers registered in 1957, 70 per cent were foreigners.

Prospective employers were assured, however, "that Guianese labor is of as good quality as any other and can be just as productive if properly trained and utilized." However, they must remember that "ever since the French came to Guiana work has been associated with the deprivation of liberty, three centuries of slavery having been followed by one of penal colonization. It is hardly surprising that there remains a certain prejudice against manual labor ...."[27]

It is even less surprising when one considers what can be gained without manual labor. Of the 12 billion francs the French Guiana government spends each year, 11 billion come from Paris, most of it for free medical treatment and public health, free care of mothers, infants, the elderly and the infirm, free education, family allowances and, not least, salaries for more than 1000 civil servants. Only 3 per cent of the 1956 budget was spent on agriculture and industry together.[28] Government policy in French Guiana is not what it was in the 18th century.

One day I was discussing the physical, social, and psychological obstacles to Guianese development with a French official who pointed to the traffic on the road: scores of autos and hundreds of motor-bikes and bicycles, scarcely a soul on foot. "The purpose of government administration," he said, "is not to produce more from a country, but to secure the happiness of its inhabitants. By and large, the Guianese are happy. If there are no millionaires, there are few paupers." The Guianese have 15,000 bicycles, many with motors, and 2000 autos, more in proportion to the population than most of Europe.[29] Development would increase the population but not necessarily promote its well-being.

Not every official shares these views. However, economic development is certainly no longer the only mainspring of French policy in Guiana. Whatever the pace of resource exploitation, the paramount consideration in Cayenne and Paris alike is that the Guianese are *French*. Since 1946 Guiana has been a *département*, larger and less populous than any other, but having the same structure and identical privileges. *Départementalisation* is more than mere political equality; it symbolizes the complete acceptance of the images and ideals of the metropolis among people of many backgrounds in this distant tropical wilderness. The *ne plus ultra* of *la mission civilisatrice*, French Guiana conforms far better than French Africa to the picture that General Charles de Gaulle recently sketched of the latter: "We have mingled everywhere, especially in Metropolitan France ... we have all learned the same language ... our minds have been trained by the same disciplines and the same orientations ... we have dreamt of the same things ... we have chosen the same ideals."[30]

French Guiana is far more French than British Guiana is British or Surinam Dutch. Except among the primitives, French is universally spoken; for most people it is the only language. As in any provincial town, so in Cayenne, is Paris the goal of all ambitious youngsters. A number of Guianese have won fame in the metropolis: the poet, Leon Damas, the Governor-General, Felix Eboué, President Gaston Monnerville. It is not just that the Guianese regard France as their homeland; in Guiana, uninterruptedly French since the 17th century, they are *in* France, although perhaps France of 1910 rather than 1960. This is apparent everywhere: in the café life, school curricula, the books and journals on sale, and the French bread available in the smallest remote settlement. Wine, liqueurs, and champagne are not merely articles of commerce; they are emblems of a culture.

In the context of Indochina and Algeria, it is easy to understand why France is proud of the harmony prevailing in French Guiana. "What a solid bulwark this South America *département* represents for France!" exclaimed a recent prefet. Here, 10,000 km. from the mother country, is "an intensely French territory, where everyone speaks, reads, and writes French, and above all thinks French with never a discordant note to trouble their sincere patriotism ... assimilation has been a complete success."[31] Gaston Monnerville, a colored Guianese, is President of the Conseil de la République. "How could France give higher proof of her willingness to carry out principles in practice? What other great power can show a similar instance?"[32] Guiana helps assuage the recent blows to national self-esteem, for here, "despite frightful ordeals, France has known how to care, in the broadest sense of the term, for a country which it has definitively stamped with its civilizing genius."[33] A member of the French Academy judges that "Guiana is already a success – even though it is still unexploited – owing to the French culture which imbues the Guianese."[34]

Indeed, these two goals – economic development and egalitarian assimilation – are to some degree antipathetic. In Guiana, as a French observer comments, "The social structure is more democratic than in the French islands, since nearly all activity is administrative and commercial";[35] with industry and agriculture so rudimentary, society is not split between a mass of agricultural workers and a few great landowners. Guianese ethnic homogeneity also makes for harmony; lacking a white plantocracy, color discrimination is not the problem it is in Martinique.[36] Among the Creoles, almost everyone is of mixed descent, European as well as African. Life in Guiana has made true Frenchmen even of the Chinese.

There are, inevitably, some flaws. The local intelligentsia, Paris-trained, outspoken, polemical, is quick to cite them. Some object that metropolitan business firms get favored treatment from the government while local people are heavily taxed for development that never takes place; others accuse the administration of holding back credits and family

allowances; still others complain that prefectoral rule of the interior is a discraceful relic of colonialism.[37] Nor is racial discrimination entirely absent. A few Antillean whites have settled in Cayenne during recent years; some officials, moreover, especially those of North African origin, appear to lack the traditional French tolerance. As one local editorialist put it, a few of them "seem to think they are still in Algeria."[38] And another charged that "assimilation is only a vain word ... *une véritable eseroquerie morale.*"[39] (a veritable moral fraud). For the most part, however, Guianese solidarity with France is impressive. During the Suez episode a Lebanese schoolboy who spoke favorably of Nasser was virtually hounded out of the country.[40] Nearly every citizen took part in the vote on de Gaulle's constitution in 1958, and Guiana backed the general by 95 per cent, compared with 87 per cent in the French Antilles.

Precisely because a major influx of population would threaten racial harmony and perhaps French culture, the Guianese have good reason to fear development requiring large-scale immigration. Logical as it might seem to build up French Guiana by unburdening overcrowded Martinique and Guadeloupe, the French government is well aware that even this would be "a ticklish matter" involving complex social, political, and economic problems; "there can therefore be no question of promoting emigration from the French West Indies to French Guiana now."[41]

French Guiana can remain the epitome of *la mission civilisatrice* perhaps only if El Dorado remains forever a mirage.

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PSYCHOLOGICAL SELF-CONSISTENCY *

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In earlier investigations,[1] my associates and I found that people differ in the way they orient themselves toward the upright in space. An individual's mode of orientation was shown further to be an expression of a more general style of perceiving which, in turn, proved to be related to particular personality characteristics. More recent studies by ourselves† and by others have extended the scope of these individual differences. A person's preferred way of perceiving is shown by these studies to be linked to a very broad and varied array of characteristics involving a great many areas of psychological functioning. A pursuit of the early observations of individual differences in space orientation has thus led to the identification of differences among people in comprehensive psychological patterns.

The existence of such encompassing patterns reflects marked self-consistency or "continuity" in individual psychological functioning. An impression of the extent of continuity may be gained from consideration of some of the attributes of people who show in their orientation a "field-dependent" way of perceiving. This kind of orientation is illustrated by performance in the "body-adjustment test," one of a series we devised for our earlier studies. In this test the subject is seated in a chair that is projected into a small room. Room and chair can be tilted to any degree, to left or right. With each tilted by set amounts, the experimenter moves the chair at the subject's direction until the subject reports himself to be upright. Meanwhile the room remains in its initial tilted position. Some people, in order to perceive themselves as upright, require that their bodies be tipped far over toward the axes of the tilted room. They determine the position of the body chiefly in relation to the axes of the visual field that immediately surrounds it. Here, and in other situations, these people find it difficult to perceive an object apart from its context or field. Their perception accordingly has been designated as field-dependent. Other people, in contrast, are able to bring the chair close to the true upright, suggesting that they perceive body position primarily with reference to sensations from within the body. In perceptual situations generally, such people are readily able to distinguish an item from its context. Their perception is "field-independent."

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† The author in collaboration with Hanna Faterson, Ruth Dyk, Donald Goodenough, and Stephen Karp.

In the general population, performances reflecting the extent of people's field dependence or independence are ranged in a continuum rather than constituting two distinct "types."

Results of our own studies and studies performed in other laboratories permit a comprehensive characterization of people who show a typically field-dependent orientation in the body-adjustment test. A few of the subjects' attributes may be cited. In puzzles resembling those frequently found in children's comics they require considerable time to find a "hidden" figure in a complex design. They find it difficult to solve problems that require that an item be used in some function other than the one it ordinarily serves. An example of such a problem is one in which a pole must be fitted into a doorway too wide to span; a cork, serving as a stopper of a nearby bottle, must be used to wedge the pole into the doorway. These people do not do well on portions of standard intelligence tests that present tasks requiring analytical ability. At the same time they do about as well as, and sometimes even better than, people with a field-independent way of perceiving on those parts of intelligence tests concerned with vocabulary, information, and comprehension, or demanding attention and concentration. Therefore they cannot be considered inferior in *general* intelligence. Material that lacks intrinsic organization, such as Rorschach ink blots, they are apt to leave unstructured and so they experience it in vague, indefinite, and "fuzzy" fashion. Their impressions of people tend to be based on relatively "external" characteristics rather than on deeper attributes.

They also manifest a tendency greatly to underestimate their own height, and two stimuli applied to the body must be relatively far apart to be experienced as separate. They are likely to change their stated view on a given issue when they learn it is in disagreement with the attitude of an "expert." At the same time, they tend to persist at tasks assigned to them by someone they view as an authority. The characters they create in stories are apt not to be interested in achievement, and their literary productions contain more inactive than active verbs. Under conditions of stress they tend to show labile psychogalvanic skin responses. Stories they make up about a picture portraying an aggressive act are likely either to "overlook" the aggression or to give it a strong, direct, unrationalized form. Nevertheless, from the standpoint of general effectiveness of adjustment or incidence of psychopathology, these people seem no different from field-independent perceivers.

With regard to most of these characteristics, people with a typically field-independent way of perceiving present a contrasting picture.

Even on superficial view the attributes of the typically field-dependent person seem, for the most part, to "belong together." So it is, also, with the attributes of the typically field-independent perceiver. In each instance we are apparently dealing with a coherent pattern of broad scope, encompassing the perceptual, intellectual, social, emotional, motiva-

tional, and defensive operations of an individual.

To this evidence of continuity across diverse areas of psychological functioning must be added our finding of marked individual consistency over extended periods of time. In longitudinal studies now in progress, we have had the opportunity to study a group of children at intervals from the ages of ten to seventeen. Performance on perceptual tests evaluating extent of field dependence was found to show a high degree of stability during this seven-year period.

The diverse specific segments of behavior cited in characterizing people with a more field-dependent or field-independent way of perceiving have been selected from among the attributes we now know that such people possess. Earlier in our work, when only some of these attributes had been identified, we already considered that the clusters they formed were, in each instance, varied expressions of an underlying, stable "core." We conceived of that core as level of differentiation, and the studies we performed to evaluate this concept served to identify many additional attributes, including some of those cited.

These studies used children as subjects. They were guided by the general hypothesis that the contrasting psychological patterns that had been observed reflected differences in extent of differentiation, expressed in diverse areas of functioning. To carry out specific tests of this hypothesis it was necessary to identify some of the more or less observable ways in which extent of psychological differentiation may be manifested. On grounds that cannot be reviewed here, we considered that a child's achievement of a high level of differentiation would be manifested principally in the following ways: a relatively developed conception of his body; a sense of his own identity and of his separateness from others; relatively clear, articulated awareness of the world around him; structured controls and defenses; and a developed capacity for initiating and directing activity.

It was anticipated that children with a relatively field-independent way of perceiving would be apt to show the postulated indicators of differentiation to a greater degree than children with a more field-dependent way of perceiving. On the premise that greater or more limited differentiation would be shown by a child in each of the indicator areas, although in varying degree, it was also expected that measures of the various indicators would be interrelated.

These expectations have been confirmed amply by the results of our intensive studies of children and related studies by other investigators, in which a variety of approaches and procedures was used.

Our next research effort was directed at determining the possible sources of differences in extent of differentiation among children. We considered that characteristics observable in infancy and constitutional in nature might contribute significantly to the differences. We considered also that the differences might be a function of life experiences of

children in the family – in relation to mother, father, and siblings – as well as in society. Because of the strategic position the mother occupies in influencing a child's development, we decided to make a start on the broad program of research required to evaluate the roles of constitutional and experiential determinants by studying mother-child relationships. We undertook these studies on the general hypothesis that children with a field-dependent style of perceiving (using this attribute to represent the broader constellation of interrelated characteristics) would have had relations with their mothers of a kind likely to hamper their opportunities for growth toward psychological differentiation.

The mother of each of a group of boys we had studied in our laboratory was interviewed at home by a staff member who had no information about the child. The interviewer sought to obtain evidence about the nature of the mother's relation, both now and in the past, to the particular child in whom we were interested. To this end, the interview explored the mother's rearing practices, her responses to the child's behavior in critical areas, her expectations for the child and complaints about him, and her evaluation of his functioning. Based on the information obtained, an evaluation was made of each mother according to whether the chief impact of her relation to her child was in the direction of hampering or contributing to his development of differentiation. These judgments were anchored to fairly specific "cues" within the evidence itself. The classification of mothers agreed significantly with the perceptual test performances of their children. Mothers judged to have relatively hampered differentiation tended to have sons who were field-dependent in their perception, and who, moreover, gave evidence of limited differentiation in most of the other "indicator" areas as well.

The relation observed between the extent of a child's differentiation and the nature of his experiences in the family has received confirmation from the results of an independent study.[2] It has also been confirmed in additional studies of our own that explored the nature of parent-child interactions from the standpoint of the child himself, as reflected in his portrayal of the parental role in TAT stories and his views of his parents given in an interview. Paralleling these investigations of the role of life experiences, we have also begun studies that may help to clarify the relation between characteristics present in infancy and the kinds of pervasive differences found in later development.

It now seems plausible to interpret the observed consistencies in behavior as reflections, in diverse areas of psychological activity, of relatively greater or more limited differentiation. An approach to psychological functioning, in terms of underlying core dimensions of the kind represented here, leads us to cut across the conventional categories often used in describing man's psychological life. Such an approach also offers the possibility of bringing together seemingly varied sorts of psychological activity into a common conceptual framework.

The field of differential psychology has amassed a large body of evidence on individual differences.[3] The research effort in this field has been directed for the most part toward the study of more or less discrete human attributes. Less has been done to explore the patterning of individual variations. The investigation of coherent constellations of characteristics in people, and their underlying bases, can help further this second important objective of differential psychology. To study variations among people in patterning of characteristics is to go beyond the problem of "individual differences," in the usual sense of variation in a particular attribute, to the important problem of "psychological individuality."

References

1. WITKIN, H. A., H. B. LEWIS, M. HERTZMAN, K. MACHOVER, P. B. MEISSNER & S. WAPNER. 1954. Personality Through Perception. Harper. New York, N.Y.

2. SEDER, J. A. 1957. The origin of differences in extent of independence in children: developmental factors in perceptual field dependence. Honors Thesis. Radcliffe College, Cambridge, Mass.

3. TYLER, L. E. 1956. The Psychology of Human Differences. 2nd ed. Appleton-Century-Crofts. New York, N.Y.

CONFERENCES HELD

SECTION OF BIOLOGICAL AND MEDICAL SCIENCES

BIOCHEMISTRY AND PHARMACOLOGY OF COMPOUNDS DERIVED FROM MARINE ORGANISMS

Wednesday, April 6
Thursday, April 7 and
Friday, April 8, 1960

Conference Chairman: Ross F. Nigrelli
Laboratory of Marine Biochemistry and Ecology
New York Aquarium, New York Zoological Society
New York, N. Y.

WEDNESDAY, APRIL 6, 1960

Session Chairman: Denis L. Fox
Scripps Institution of Oceanography
University of California
La Jolla, Calif.

9:00 A.M. –
Greetings from the Academy – Charles Noback, Vice-Chairman, Section of Biological and Medical Sciences, The New York Academy of Sciences, New York, N. Y.; College of Physicians and Surgeons, Columbia University, New York, N. Y.

Introductory Remarks – "Perspectives in Marine Biochemistry" – Denis L. Fox, Scripps Institution of Oceanography, University of California, La Jolla, Calif.

"An Investigation of the Distribution and Function of Homarine (*N*-Methyl Picolinic Acid)" – Edgar L. Gasteiger, Harvard Medical School, Boston, Mass.

"Pharmacologically Active Amines and Their Biogenesis in the Octopus" – William J. Hartman, William G. Clark, Shirley D. Cyr, Albert L. Jordan, and Ruth A. Liebhold, Veterans Administration Center and University of California Medical Center, Los Angeles, Calif.

"Some Chemical Properties of Nereistoxin" – Yoshiro Hashimoto and Tomotoshi Okaichi, University of Tokyo, Bunkyo-Ku, Tokyo, Japan.

"Occurrence of Tetramine and Choline Compounds in the Salivary Gland of a Marine Gastropod, *Neptunea arthritica* Bernardi" – Motokazu Asano, Tohoku University, Sendai, Japan.

"Pharyngeal Glands of *Neptunea antiqua*" – Ragnar Fänge, Institute of Zoophysiology, University of Oslo, Blindem, Norway.

Session Chairman: Ernest Baldwin
University College of London
London, England

2:00 P.M. –
"Pharmacologically Active Choline Esters in Marine Gastropods" – V. D. Whittaker, Agricultural Research Council, Institute of Animal Physiology, Babraham, Cambridge, England.

"Preliminary Studies on the Venom of the Marine Snail *Conus*" – A. J. Kohn, Florida State University, Tallahassee, Fla.; P. R. Saunders, School of Medicine, University of Southern California, Los Angeles, Calif.; and S. Wiener, Prince Henry's Hospital, Melbourne, Australia.

"Cephalotoxin: Chemical and Pharmacological Properties" – F. Ghiretti, Stazione Zoologica, Naples, Italy.

"The Toxin of *Physalia* Nematocysts" – Charles E. Lane, The Marine Laboratory, University of Miami, Miami, Fla.

"Mechanism of Action of a Histamine-Liberating Principle in Jellyfish (*Cynea capillata*)" – Börje Uvnäs, Karolinska Institutet, Stockholm, Sweden.

"Antibodylike Materials of Marine Invertebrates" – John H. Phillips, University of California, Berkeley, Calif.

THURSDAY, APRIL 7, 1960

Session Chairman: Bruce W. Halstead
World Life Research Institute
Colton, Calif.

9:00 A.M. –
"Ciguatera Poison" – Bruce W. Halstead and Donald W. Hessel, World Life Research Institute, Colton, Calif.

"Pharmacological and Chemical Studies of the Venom of Some Scorpion Fishes" – Paul R. Saunders, School of Medicine, University of Southern California, Los Angeles, Calif.

"Zootoxicological Properties of the Venoms of the Sting Rays and Weeverfishes" – Findlay E. Russell, Laboratory of Neurological Re-

search, College of Medical Evangelists, Los Angeles, Calif.

"Phamacological Study of Poisons from Shellfish and Pufferfish" – Edmund F. Murtha, United States Chemical Warfare Laboratories, Army Chemical Center, Aberdeen, Md.

Session Chairman: Luigi Provasoli
Haskins Laboratories
New York, N. Y.

2:00 P.M. –

"Toxicological Effects of Food Poisoning Due to Oysters and 'Baby' Clams" – Tomochiro Akiba, School of Medicine, University of Tokyo, Tokyo, Japan.

"Analyses of the Toxin Produced by Axenic Cultures of *Gonyaulax catanella*" – John Burke, St. Francis College, Brooklyn, N. Y.; John Marchisotto, St. John's University, Brooklyn, N. Y.; John J. McLaughlin and Luigi Provasoli, Haskins Laboratories, New York, N. Y.

"Biochemical Studies on Paralytic Shellfish Poison" – Edward J. Schantz, United States Army Medical Corps Research and Development Command, United States Army Biological Warfare Laboratories, Fort Detrick, Frederick, Md.

"Mass Cultivation of Phytoplankton" – John J. McLaughlin and P. A. Zahl, Haskins Laboratories, New York, N. Y.; A. Nowak, St. Francis College, Brooklyn, N. Y.; and John Marchisotto, St. John's University, Brooklyn, N. Y.

"Studies on the Toxic Principle Formed by the Chrysomonad *Prymnesium parvum* Carter" – M. Shilo and R. Rosenberger, Laboratory of Microbiological Chemistry, Hebrew University-Hadassah Medical School, Jerusalem, Israel.

7:00 P.M. –

"Steroids in Marine Organisms" – G. A. D. Haslewood, Biochemistry and Chemistry Department, Guy's Hospital Medical School, London, England.

FRIDAY, APRIL 8, 1960

Session Chairman: Harry Sobotka
Mt. Sinai Hospital
New York, N. Y.

9:00 A.M. –

"Effects of Holothurin, a Steroid Saponin from the Bahamian Sea Cucum-

ber (*Actinopyga agassizi*), on Various Biological Systems" – Ross F. Nigrelli and Sophie Jakowska, Laboratory of Marine Biochemistry and Ecology, New York Aquarium, New York Zoological Society, New York, N. Y.

"Some Pharmacological Properties of Holothurin A" – F. G. Friess, Naval Medical Research Institute, Bethesda, Md.; F. G. Standaert, National Institute of Neurological Diseases and Blindness, Public Health Service, Bethesda, Md.; E. R. Whitcomb and R. F. Nigrelli, Laboratory of Marine Biochemistry and Ecology, New York Aquarium, New York Zoological Society, New York, N. Y.; J. D. Chanley and Harry Sobotka, Mt. Sinai Hospital, New York, N. Y.

"Further Studies on the Structure of Holothurin" – J. D. Chanley and J. Pearlstein, Mt. Sinai Hospital, New York, N. Y.; Ross F. Nigrelli, Laboratory of Marine Biochemistry and Ecology, New York Aquarium, New York Zoological Society, New York, N. Y.; and Harry Sobotka, Mt. Sinai Hospital, New York, N. Y.

"Sterols of Some Invertebrates" – Irving I. Domsky, Yale University, New Haven, Conn.

"Sterols of Molluscs" – Charles Albert Kind, University of Connecticut, Storrs, Conn.

Session Chairman: Ross F. Nigrelli
Laboratory of Marine Biochemistry and Ecology
New York Aquarium, New York Zoological Society
New York, N. Y.

2:00 P.M. –

"Antibacterial Substances from Sponges" – Sophie Jakowska and Ross F. Nigrelli, Laboratory of Marine Biochemistry and Ecology, New York Aquarium, New York Zoological Society, New York, N. Y.

"Comparative Biochemistry of Gorgonians" – Leon S. Ciereszko, University of Oklahoma, Norman, Okla.

"Phosphagens of Marine Animals" – Nguyen van Thoai and J. Roche, Laboratoire Maritime du Collège de France, Concarneau Finistère et Laboratoire Biochemie Gènerale et Comparèe, Collège de France, Paris, France.

"Tryptophan Synthetase in Marine Algae from the Upper Gulf of Mexico" – Howard J. Teas, University of Florida, Gainesville, Fla.

"Comparative Marine Biochemistry – Some Summary Remarks" – Ernest Baldwin, University College of London, London, England.

Robert L. Kroc
Chairman

Charles Noback
Vice-Chairman

DIVISION OF PSYCHOLOGY

FUNDAMENTALS OF PSYCHOLOGY: THE PSYCHOLOGY OF THINKING

Thursday, April 28 and
Friday, April 29, 1960

Conference Chairman: J. P. Guilford
University of Southern California
Los Angeles, Calif.

THURSDAY, APRIL 28, 1960

THEORETICAL ASPECTS OF THE PSYCHOLOGY OF THINKING

Session Chairman: Margaret E. Tresselt
New York University
New York, N. Y.

9:00 A.M. –
Greetings from the Academy – Gregory Razran, Chairman, Division of Psychology, The New York Academy of Sciences, New York, N. Y.; Queens College, New York, N. Y.

Introductory Remarks – Ernest Harms, Grand Central Hospital, New York, N. Y.

"Basic Conceptional Problems of the Psychology of Thinking" – J. P. Guilford, University of Southern California, Los Angeles, Calif.

"Individual and Collective Problems of the Psychology of Thinking" – Jerome S. Brunner, Harvard University, Cambridge, Mass.

"Thinking and Speaking" – Kurt Goldstein, New School of Social Research, New York, N. Y.

DEVELOPMENTAL PROBLEMS OF THE PSYCHOLOGY OF THINKING

Session Chairman: Donald M. Johnson
Michigan State University
East Lansing, Mich.

2:00 P.M. –
"Development of Thinking: A Genetic Approach" – Jean Piaget, University of Geneva, Geneva, Switzerland.

"Learning, Development, and Thinking" – Tracy S. Kendler, Barnard College, Columbia University, New York, N. Y.

"Pattern in the Development of Thinking" – Martin Scheerer, University of Kansas, Lawrence, Kans.

FRIDAY, APRIL 29, 1960

MEASUREMENT OF THINKING

Session Chairman: Jerome S. Brunner
Harvard University
Cambridge, Mass.

9:00 A.M. –

"Serial Analysis of Thinking" – Donald M. Johnson, Michigan State University, East Lansing, Mich.

"Relations Between Motivational Conditions and Thinking" – W. Edgar Vinacke, University of Hawaii, Honolulu, Hawaii.

"Experimental Studies of the Role of Verbal Processes in Problem Solving and Concept Formation" – Charles N. Cofer, New York University, New York, N. Y.

CREATIVITY AND THINKING

Session Chairman: Ernest Harms
Grand Central Hospital
New York, N. Y.

2:00 P.M. –

"Thinking and Creativity" – Donald W. Taylor, Yale University, New Haven, Conn.

"New Aspects of the Creativity Problem in Thinking" – Abraham S. S. Luchins, University of Florida, Miami, Fla.

"Ideational Reorganization in Creative and Noncreative Thinking" – Livingston Welch, Hunter College, New York, N. Y.

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Margaret E. Tresselt, New York University, New York, N. Y.

SECTION OF BIOLOGICAL AND MEDICAL SCIENCES

AND DIVISION OF MICROBIOLOGY

BIOCHEMICAL ASPECTS OF MICROBIAL PATHOGENICITY

Thursday, April 28
Friday, April 29 and
Saturday, April 30, 1960

Conference Co-Chairmen:

Werner Braun, Institute of Microbiology
Rutgers, The State University
New Brunswick, N. J.
and
D. V. Siva Sankar, Creedmoor State Hospital
Creedmoor, N. Y.

THURSDAY, APRIL 28, 1960

A. BIOCHEMICAL PROPERTIES OF VIRULENT AND AVIRULENT STRAINS OF BACTERIA

Session Chairman: W. J. Nungester
University of Michigan
Ann Arbor, Mich.

9:00 A.M. –
Greetings from the Academy – Robert L. Kroc, Chairman, Section of Biological and Medical Sciences, The New York Academy of Sciences, New York, N. Y.; Warner-Lambert Research Institute, Morris Plains, N. J.

Opening Remarks – D. V. Siva Sankar, Creedmoor State Hospital, Creedmoor, N. Y.

"*Bacillus anthracis*" – C. Thorne, United States Army Biological Warfare Laboratories, Fort Detrick, Md.

"Streptococci" – S. S. Barkulis, CIBA Pharmaceutical Products, Inc., Summit, N. J.

"Pneumococci" – W. Firshein, Wesleyan University, Middletown, Conn.

"*Mycobacterium tuberculosis*" – H. Bloch, University of Pittsburgh, Pittsburgh, Pa.

"Other Mycobacteria" – J. Hanks, Johns Hopkins University, Baltimore, Md.

Session Chairman: W. W. Umbreit
Rutgers, The State University
New Brunswick, N. J.

2:00 P.M. –

"*Cornybacterium diphtheriae*" – L. Barksdale, New York University College of Medicine, New York, N. Y.

"*Clostridium botulinum*" – C. Lamanna, Naval Biological Laboratory, University of California, Berkeley, Calif.

"Staphylococci" – J. Burns, Baroness Erlanger Hospital, Chattanooga, Tenn., and F. Holtman, University of Tennessee, Nashville, Tenn.

"Salmonellae, *Pasteurella pestis* (I)" – T. W. Burrows, Microbiological Research Establishment, Porton, England.

"*Pasteurella pestis* (II)" – M. Surgalla, United States Army Biological Warfare Laboratories, Fort Detrick, Md.

"*Pasteurella pestis* (III)" – S. J. Ajl, National Science Foundation, Washington, D. C., and J. Rust, Jr., Walter Reed Army Institute of Research, Washington, D. C.

A. BIOCHEMICAL PROPERTIES OF VIRULENT AND AVIRULENT STRAINS OF BACTERIA *(Contd.)*

FRIDAY, APRIL 29, 1960

Session Chairman: D. W. Watson
University of Minnesota
Minneapolis, Minn.

9:00 A.M. –

"Brucellae" – J. B. Wilson and B. L. Dasinger, University of Wisconsin, Madison, Wis.

"Shigellae" – H. M. Watkins, Naval Biological Laboratory, University of California, Berkeley, Calif.

"*Klebsiella, Erwinia, and Pseudomonas*" – E. Garber, University of Chicago, Chicago, Ill.

"*Hemophilus*" – G. Leidy, Columbia University, New York, N. Y.

"Vibrios" – C. Lankford, University of Texas, Austin, Texas.

B. SPECIAL PROBLEMS OF HOST-PARASITE RELATIONSHIPS

Session Chairman: W. Braun
Rutgers, The State University
New Brunswick, N. J.

2:00 P.M. –

"Studies on Organisms Grown *in Vivo* to Reveal the Basis of Microbial Pathogenicity" – H. Smith, Microbiological Research Establishment, Porton, England.

"Modified Serum Resistance of Bacteria Following Intracellular Residence" – W. Stinebring and W. Braun, Institute of Microbiology, Rutgers, The State University, New Brunswick, N. J., and A. Pomales-Lebrón, University of Puerto Rico, San Juan, Puerto Rico.

"Nonspecific and Specific Cellular Reactions to Infection" – E. Suter, University of Florida, Gainesville, Fla.

"Irradiation, Immunization, and Sensitivity to Toxic Substances, Considerations in a Concept of Cellular Immunity" – E. Nelson and R. S. Berk, University of California, Los Angeles, Calif.

"Serum Bactericidal Action" – L. H. Muschel, Walter Reed Army Institute of Research, Washington, D. C.

"Inactivation of Endotoxin by Humoral Systems" – M. Landy, National Cancer Institute, Public Health Service, Bethesda, Md.

B. SPECIAL PROBLEMS OF HOST-PARASITE RELATIONSHIPS *(Contd.)*

SATURDAY, APRIL 30, 1960

Session Chairman: Frank L. Horsfall, Jr.
The Rockefeller Institute
New York, N. Y.

9:00 A.M. –

"Some Metabolic Aspects of Host-Parasite Interactions in the Mouse Typhoid Model" – L. J. Berry, Bryn Mawr College, Bryn Mawr, Pa.

C. SOME RICKETTSIAL AND VIRAL PROBLEMS

"Rickettsiae" – E. Weiss, Naval Medical Research Institute, Bethesda, Md.

"Virus-Induced Alterations of Host Metabolism" – J. Flaks, University of Pennsylvania, Philadelphia, Pa.

"Chemistry of Viral Infected Cells" – W. Ackermann, University of Michigan, Ann Arbor, Mich.

"Interferon as a Chemical Intermediary in Viral Interference" – R. R. Wagner and A. H. Levy, Johns Hopkins University, Baltimore, Md.

"Some Aspects of the Virulence of Certain Human Viruses" – W. H. Price and R. Lee, III, Johns Hopkins University, Baltimore, Md.

"Summation and Perspectives" – Colin MacLeod, University of Pennsylvania, Philadelphia, Pa.

SECTION OF BIOLOGICAL AND MEDICAL SCIENCES

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DIVISION OF MICROBIOLOGY

Karl Maramorosch
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NEW MEMBERS

Elected April 21, 1960

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Elsberg, Paul, M.D., Physiology-Anesthesiology. Assistant Chief, Doctor's Hospital, Washington, D. C.

Walker, Hector McDonald, M.D., Pathology. Director, Glaxo Laboratories, Ltd., London, England.

ACTIVE MEMBERSHIP

Abbott, Donald C., B.S., Biochemistry of Cereal Grains. Assistant Professor, Biochemistry, Oklahoma State University, Stillwater, Okla.

Abere, Joseph F., Ph.D., High Polymers. Project Manager, Chemical Division, Minnesota Mining & Mfg. Co., St. Paul, Minn.

Abraham, George, B.Sc., Solid State Electronics. Solid State Physicist, U.S. Naval Research Laboratory, Washington, D. C.

Abrams, Jules C., Ph.D., Clinical Psychologist. Private Practice, Philadelphia, Pa.

Acevedo, Juan E., M.D., Cardiology. Puerto Rico Health Department, Mayaguez, Puerto Rico.

Ackerman, Joseph I., Jr., Ph.D., Organic Chemistry. Technical Director, Deecy Products Company, Cambridge, Mass.

Adams, Raymond W., M.D., Neuropathology. Chief, Neurology Service, Massachusetts General Hospital, Boston, Mass.

Adams, Whitney R., Ch.E., Chemical Engineering. Senior Research Engineer, Scott Paper Company, Chester, Pa.

Adler, Jonathan Henry, Ph.D., Veterinary Physiology. Head, Department of Physiology and Biochemistry, Ministry of Agriculture, Veterinary Institute, Beit Dagon, Israel.

Agamian, Saribek, Ph.D., Physiology and Chemistry of Plants. Chief Chemist, Bernard Food Industry Incorporated, San Jose, Calif.

Agnello, Eugene J., Ph.D., Organic Chemistry. Research Chemist, Charles Pfizer & Company, Brooklyn, N. Y.

Aines, Philip D., Ph.D., Biochemistry. Head, Basic Development, Food Division, The Procter & Gamble Company, Cincinnati, Ohio.

Albers, Henry John, Ph.D., Biochemistry of Reproduction. Worcester Foundation of Experimental Biology, Shrewsbury, Mass.

Albers, Vernon Martin, Ph.D., Underwater Acoustics. Chief Scientist and Professor of Engineering Research, Pennsylvania State University, University Park, Pa.

Albertson, John Newman, Jr., B.A., Research. Chief Bacteriologist and Serologist, Valley Forge General Hospital, Phoenixville, Pa.

Alcott, Donald L., M.D., Pathologist. Director of Laboratories, Santa Clara County Hospital, San Jose, Calif.

Allard, Romeo P., Ph.D., Chemistry. Professor of Chemistry, Loyola University of Los Angeles, Los Angeles, Calif.

Allen, Donald Stewart, Ph.D., Physical Chemistry. Professor of Chemistry, State University College of Education, Albany, N. Y.

Allen, Frank Worthington, Ph.D., Biochemistry. Professor of Biochemistry, University of California School of Medicine, San Francisco, Calif.

Allen, Leland C., Ph.D., Electronic Structure of Matter. National Science Foundation Postdoctoral Fellow, University of California, Berkeley, Calif.

Almon, Lois, Ph.D., Clinical Laboratory Procedures. Technical and Educational Supervisor, Laboratories, Mt. Sinai Hospital, Milwaukee, Wis.

Almquist, H. J., Ph.D., Biochemistry. Vice President and Director of Research, The Grange Company, Modesto, Calif.

Althausen, Darrell, B.Sc., Organic Chemistry. Head, Product Research and Development Department, The Coca-Cola Company, New York, N. Y.

Anderson, Wilford Hoyt, Ph.D., Detonation and Combustion Processes. Technical Specialist, Aerojet-General Corporation, Azusa, Calif.

Anderson, David W., Jr., Ph.D., Pharmaceutical. Director of Research, The Borden Company, New York, N. Y.

Anderson, George Woodrow, M.D., Obstetrics. Director of Laboratories, Providence Lying In Hospital, Providence, R. I.

Appleton, Harold D., Ph.D., Lipids. Senior Chemist, Metropolitan Hospital, New York, N. Y.

Aronson, Roland Sigurd, M.D., Cancer Control. Chief, Laboratory Service, Walter Reed General Hospital, Washington, D. C.

Bairstow, Bruce Allen, M.D., Dermatology. Staff, Hitchcock Clinic, Hanover, N. H.

Baker, Emory F., M.D., Medicine. Private Practice, Spokane, Wash.

Baker, Seward J., M.D., Medicine. Orange Memorial Hospital, Orange, N. J.

Birkhead, Newton C., M.D., Cardiovascular Physiology. Head, Metabolic Ward, Lankenau Hospital, Philadelphia, Pa.

Biscardi, Salvatore, B.A., Pharmacology. Assistant Scientist, Warner-Lambert Research Institute, Morris Plains, N. J.

Boggs, Richard Pryde, B.A., Cardiovascular Research. Medical Student, University of California, Los Angeles, Calif.

Bouland, Thomas Green, Jr., M.D., Surgery. Private Practice, Madison, Fla.

Bowman, Edward R., M.D., Pharmacology. Predoctoral Research Fellow, National Heart Institute, Richmond, Va.

Brotman, David M., M.D., Blood Diseases. Medical Director, Culver City Hospital and Valley Doctors Hospital, Culver City, Calif.

Burke, Keith E., M.S., Analytical Chemistry. Research Chemist, Atomic Energy Commission at Iowa State University, Ames, Iowa.

Cabrera, Guillermo Palomo, M.D., Surgery. Chief Resident in Surgery, William Beaumont Hospital, Royal Oak, Mich.

Cannon, James Alfred, M.D., Psychiatry. Resident Psychiatrist, University of California at Los Angeles Psychiatric Institute, Los Angeles, Calif.

Chauncey, Howard H., Ph.D., Physiology of the Oral Cavity. Assistant Professor, Tufts University School of Dental Medicine, Boston, Mass.

Cole, Gerald A., B.S., Microbiology. Virologist, University of Maryland School of Medicine, Baltimore, Md.

Cooper, Elmer E., M.D., Medicine. Private Practice, San Antonio, Texas.

Cords, Helmuth, Ph.D., Chemistry. Director of Research, Bioferm Corporation, Wasco, Calif.

Davidson, Wallace Lee, M.D., Industrial Medicine. Director, Industrial Health, Merck Sharp & Dohme, Philadelphia, Pa.

Dayharsh, Carroll A., Ph.Ch., Fermentation. Chief Chemist, Jacob Ruppert, New York, N. Y.

De George, Frances V., M.A., Genetics-Medical. Research Associate, Division of Preventive Medicine, Sloan-Kettering Institute for Cancer Research, New York, N. Y.

D'Errico, Albert, M.D., Neurological Surgery. Chief, Baylor University Hospital, Dallas, Texas.

Desenne, Jean J., M.D., Internal Medicine. Assistant Professor, Medicine, Universidad Central de Venezuela, Caracas, Venezuela.

De Vitre, Homi R., M.D., Cardiology. Physician, Clinical Research, Geigy Pharmaceuticals, Ardsley, N. Y.

Dirmitt, Jean, B.S., Viruses. Virologist, Merck Sharp & Dohme, West Point, Pa.

Erickson, Robert W., B.A., Neurochemistry. Jr. Biochemist, Smith Kline & French Laboratories, Philadelphia, Pa.

Firey, Frank Paul, M.D., Biological Chemistry. Private Practice, Portland, Oreg.

Gaillard, P. J., M.D., Experimental Histology and Tissue Culture. Professor, Cytology, State University of Leiden, Leiden, Netherlands.

Gaspar, Mary, M.S., Cardiovascular Renal Physiology. Research Associate, Department of Physiology, Howard University School of Medicine, Washington, D. C.

Gemez-Rieux, Charles, M.D., Bacteriology. Director, l'Institut Pasteur de Lille, Lille, France.

Goldfarb, Arthur A., M.D., Allergy and Medicine. Assistant Professor, Albert Einstein College of Medicine, New York, N. Y.

Goodman, Morris Franklin, B.A., Linguistics and Psycho-linguistics. Research Associate, Psychometric Laboratory, University of North Carolina, Chapel Hill, N. C.

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Gyorko, Alejandro Carlos, M.D., Climatology and Internal Medicine. Private Practice, Canary Islands, Spain.

Hader, Rodney N., B.S., Agricultural and Food Chemistry. Editor, Journal of Agricultural and Food Chemistry, Washington, D. C.

Harris, June T., Ph.D., Psychology. Supervisor of Psychologists in charge of Research and Development, Bureau of Child Guidance, New York, N. Y.

Healey, John E., Jr., M.D., Experimental Surgery. Chief, Experimental Surgery, University of Texas, M. D. Anderson Hospital, Houston, Texas.

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